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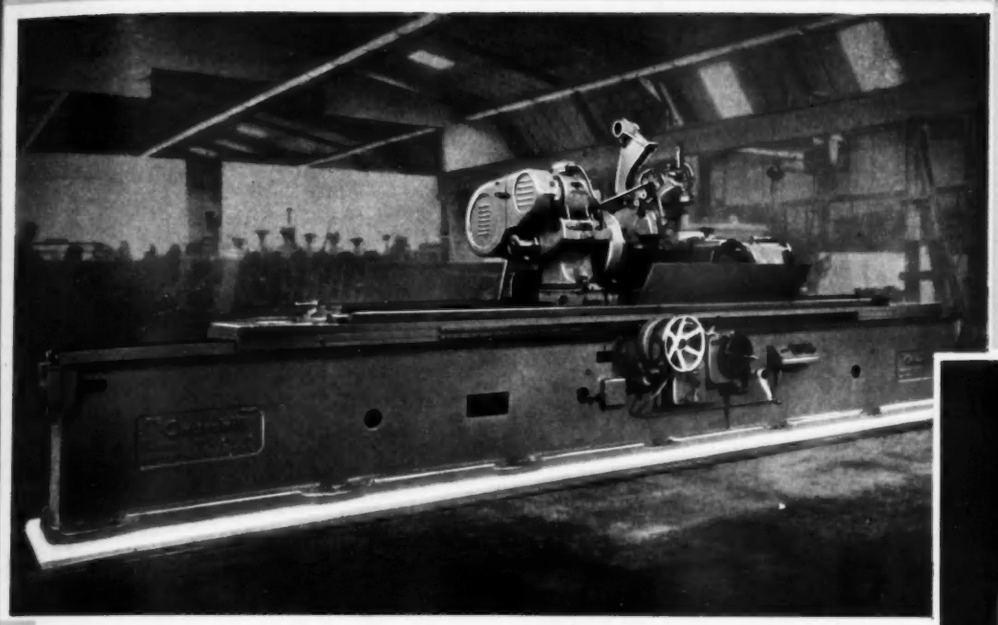

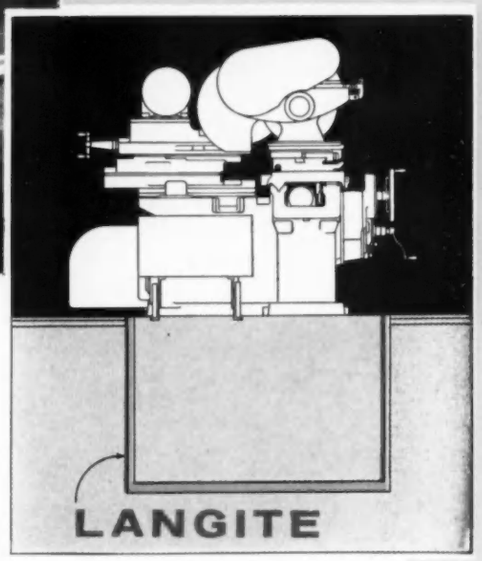

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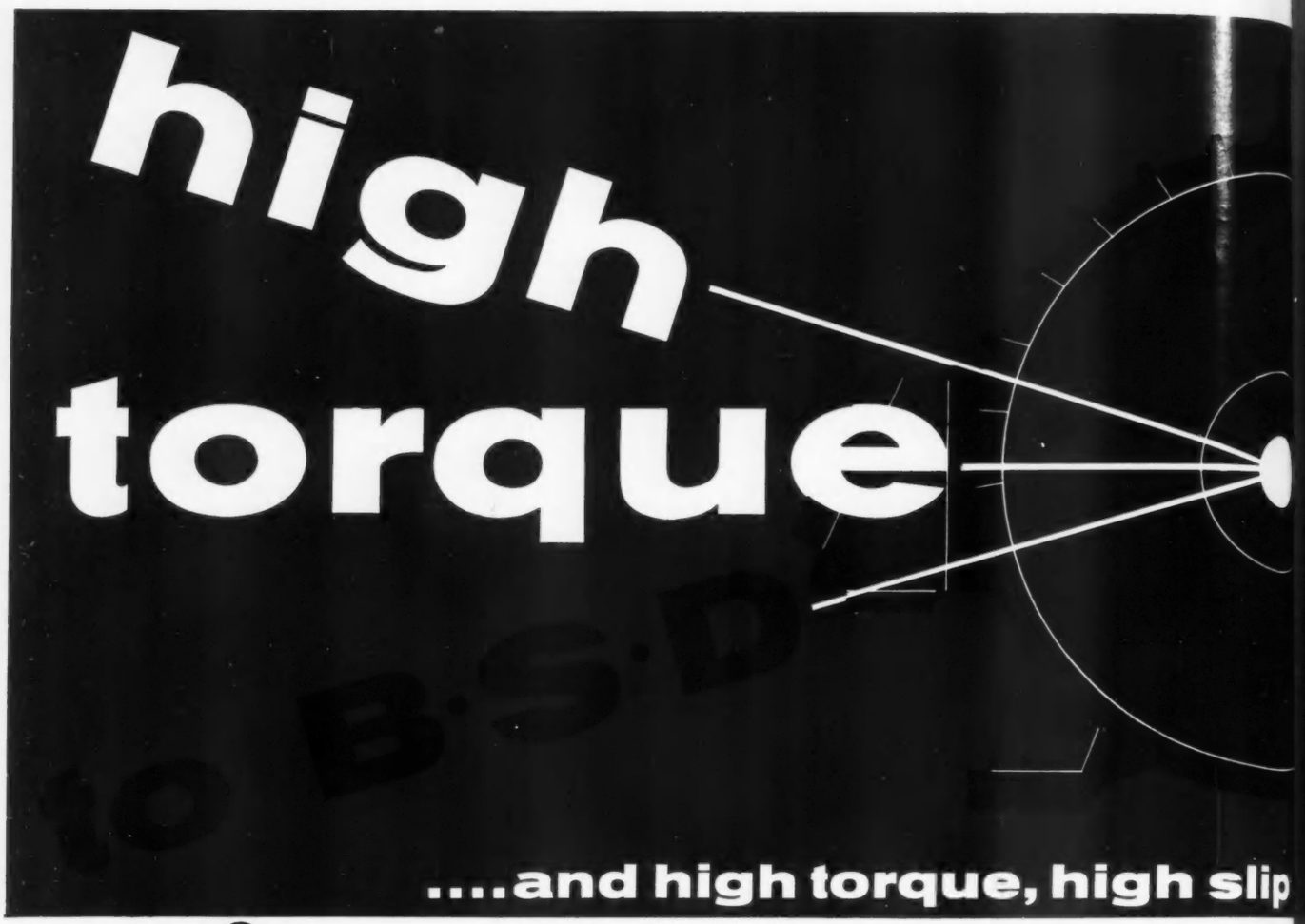

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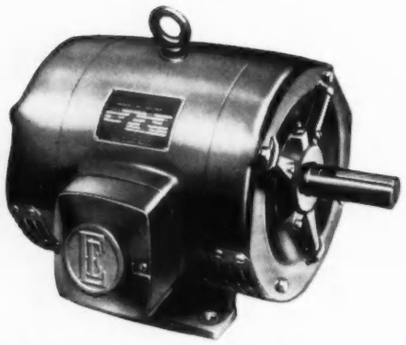

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SUBSCRIPTIONS U.K. and ABROAD £5 10. 0. p.a., including postage (CANADA £5 5. 0.). Single copies 2s. each, plus 9d. postage. Also on sale at newsagents.

'THE ENGINEER' BUYERS GUIDE Published annually. One FREE copy is sent to all direct postal subscribers on publication and delivered by newsagents to all regular readers. Additional copies are obtainable at 10s. 0d. each. Postage 2s. 0d. extra.

Published every Friday by
MORGAN BROTHERS (PUBLISHERS) LTD., AT 28, ESSEX STREET, STRAND, LONDON, W.C.2. Telephone : CENtral 6565

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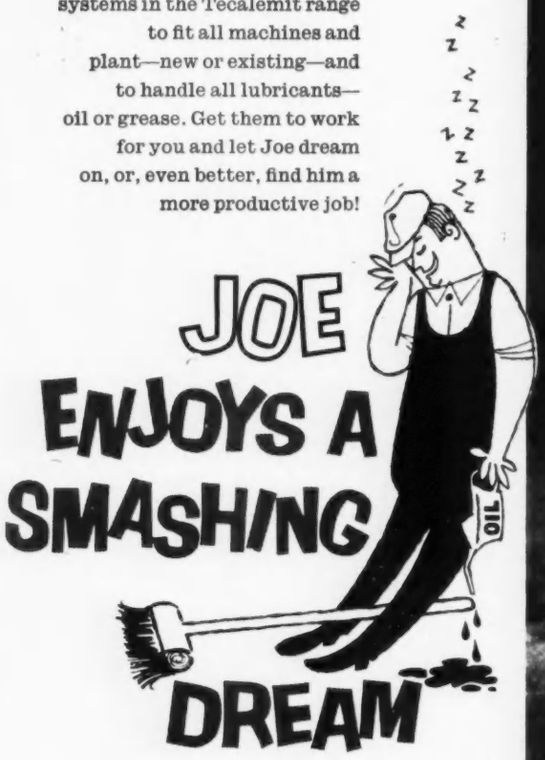

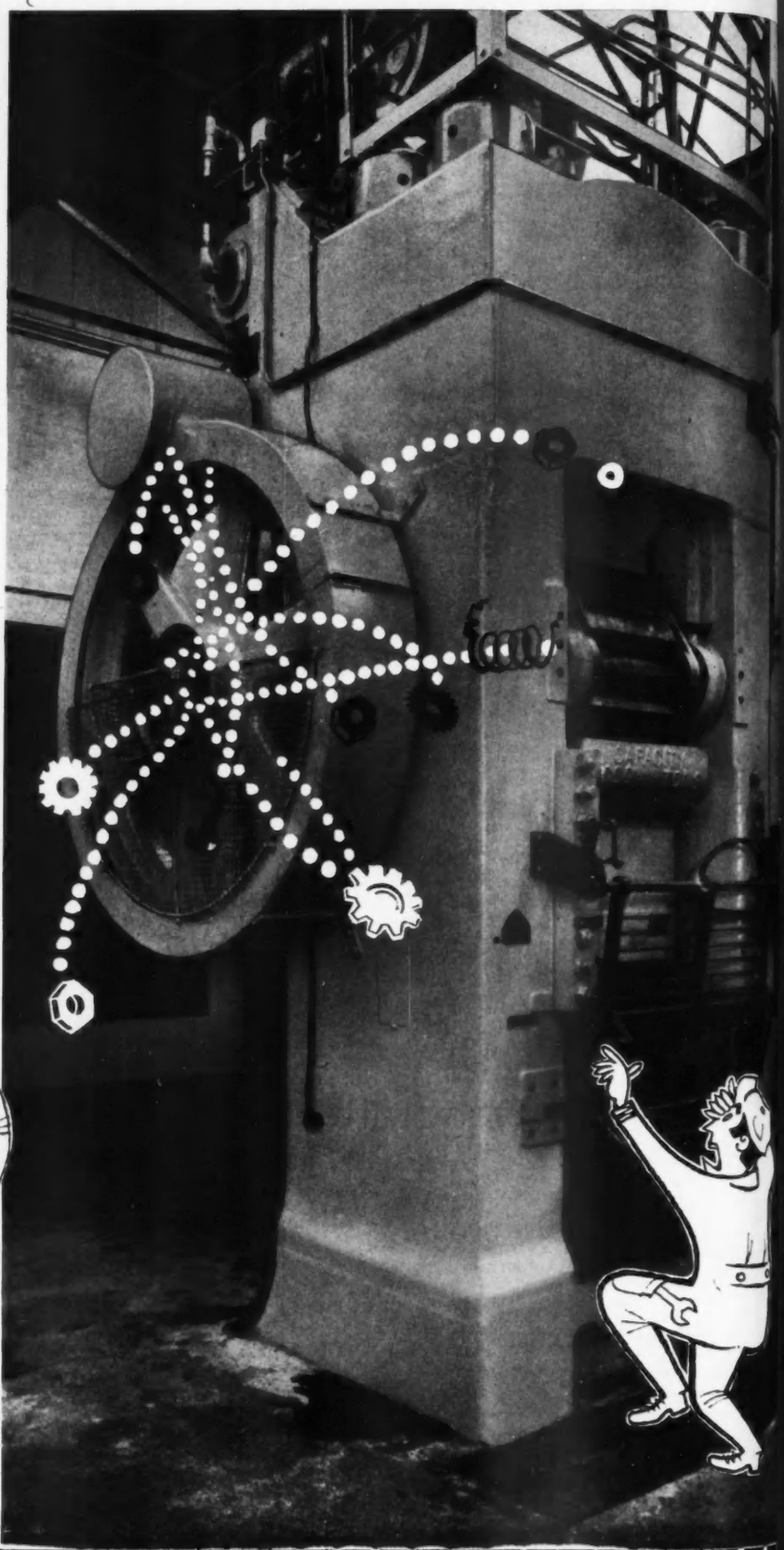

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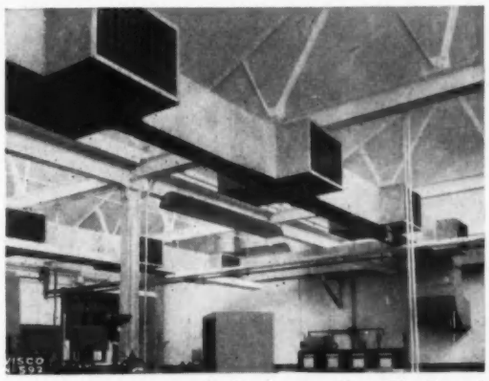

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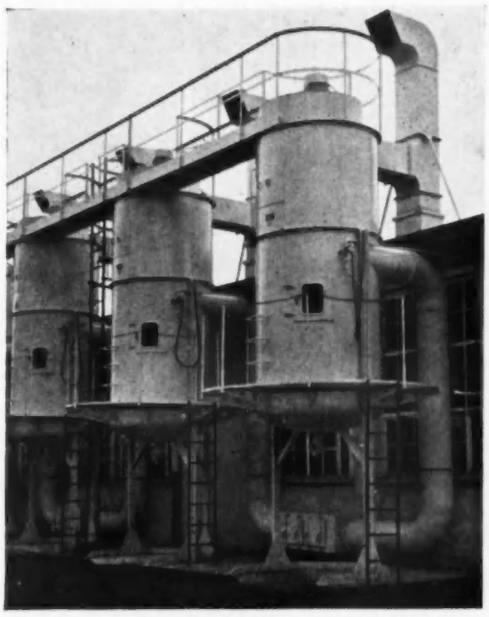

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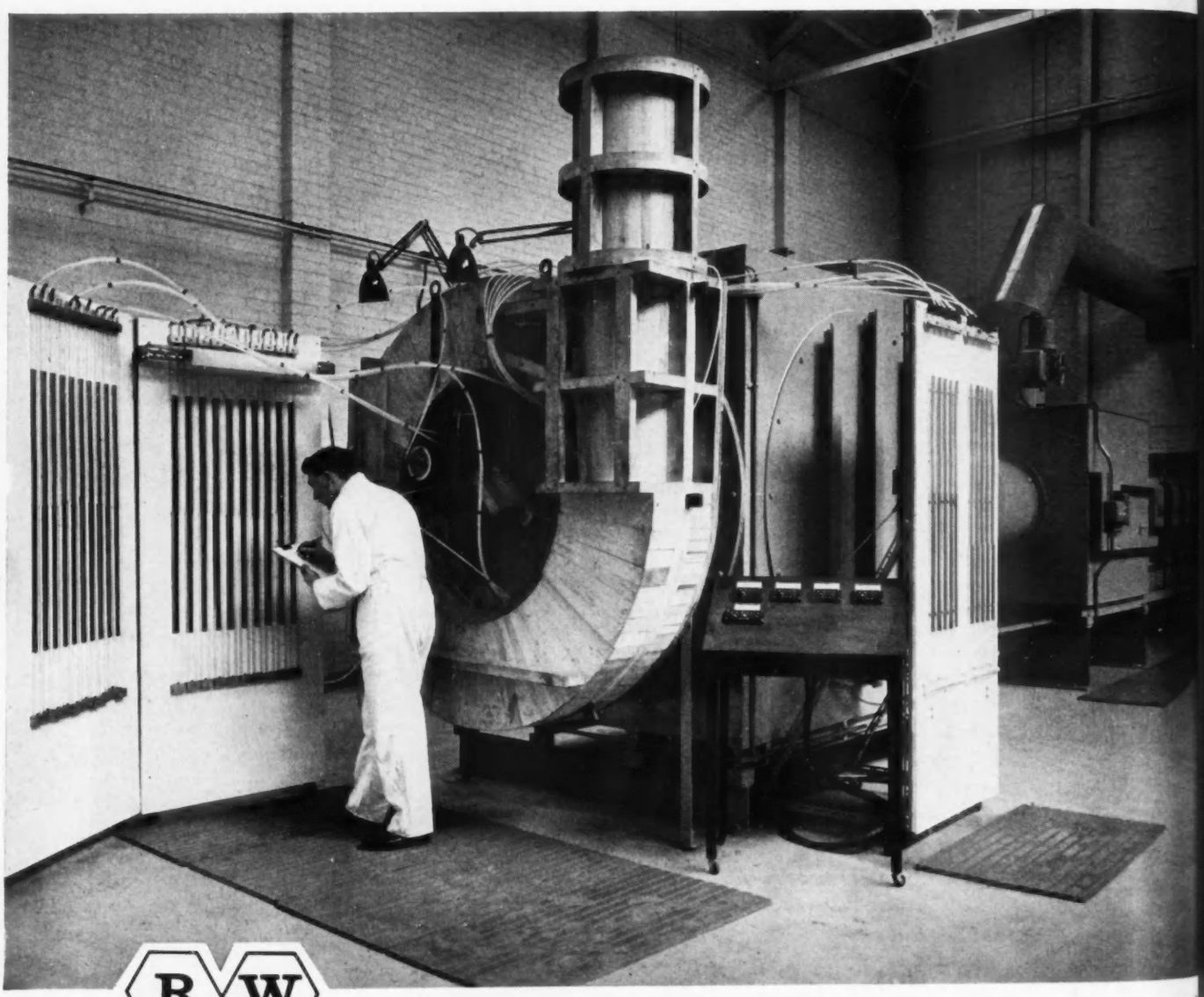

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THE ENGINEER

No. 5506 AUGUST 4, 1961 Vol. 212

BRITAIN AND THE E.E.C.

Few engineers, we think, will doubt that it is right for this country to make a formal application to join the European Economic Community, bearing in mind, of course, that by making application the country is not definitely committing itself to join but only making it possible to open negotiations so as to discover what terms can be arranged. It is true, of course, that only very few of the people of this country as a whole have made up their minds already as between joining the Community or standing aside and attempting to develop the Commonwealth instead. They have done so, we think, more on emotional grounds than upon sound reasoning. These who undoubtedly already oppose the step do so out of attachment to the Royal Family and to the Commonwealth of which the Queen is the Head, out of fears that Britain would lose its sovereignty so that many of its affairs might be decided not by the British people but by a lot of Germans, Frenchmen and Italians, and out of a conviction that Western European nations, far from wishing this country well, would like it to join the Community only to bring about its economic ruin. Those who are already convinced that this country ought to join, almost upon any terms, fear, contrariwise, that a Britain excluded from the wide European common market must necessarily be unable to compete, not only within that market, but also elsewhere in the world with European manufacturers, so that its standard of living must fall, at least relatively, and its influence upon world affairs decline. But for the most part the people of this country remain quite undecided about anything except that they would like to know more certainly what the consequences of joining the Community would be.

For engineers the situation is, we think, rather different. For them there is something very attractive about the idea of getting within a market which might cover some 300 million people and which is potentially amongst the biggest and most highly developed on the earth's surface. Engineers in the more vigorous firms would, we suggest, welcome the stimulus of competing in such a market; for it could provide high rewards for technical and commercial success. Statistics already show how effective the partial removal of trade barriers amongst the Six in the Community has already proved in stimulating mutual trade and causing output to expand. Technically it also makes good sense that Britain should join the Community when such expensive things as the development of nuclear power and the building of satellite launchers are being undertaken internationally, when much research in engineering fields is being done internationally too; when the results of research, wherever undertaken, ought to be applied internationally, and when an increasing number of engineering firms are becoming international, too, in the sense that subsidiary factories are set in operation in other countries than that in which the parent firm is situated. There is, too, for engineers the exciting possibility in the future that barriers other than those of trade may come down so that they will be more free to move about, to get educated, and to find jobs anywhere within Western Europe.

Others, however, must certainly feel less excited. Many industrialists, for example, and boards of directors, even of engineering firms, will note that their trade with Western Europe is substantially smaller than their trade with other regions, notably the Commonwealth; though they may note also, that relatively, trade with Western Europe is growing faster. They may also take note that Imperial preferences within the Commonwealth have been eroded away as the years have passed and are now less valuable to British manufacturers than they used to be. Still there remains within the Commonwealth the habit and desire to buy British. That goodwill is something which should not be risked unless there are substantial gains to be found elsewhere. Its loss would certainly be too high a price to pay for entry into the European Economic Community. Again, though there is much that is attractive to engineers about joining the common market, the project appears in a very different light to some other people. We do not, for example, pretend to know much about the politics and economics of farming. But we do know that, in effect, agriculture is subsidised in Britain and protected in one way or another in most European countries. Farmers here will need to be reassured that their interests will not suffer. Again there are many who have fears, which are probably misplaced, about the effects of joining the Community. Amongst trades unionists there may be many who will look askance at the idea that, for example, Italy might export many of its impoverished unemployed to this country; and there is, we fancy, a good deal of misconception amongst rank and file trades unionists and amongst boards of management too, about the levels of wages in other European countries.

When the negotiations open, at the end of this month or early in September, it may, of course, soon become apparent that the terms upon which the Community would accept the United Kingdom into its ranks would conflict too markedly with the special interests of the Commonwealth or of the European Free Trade Association or with sectional interests in this country. Britain and its E.F.T.A. partners would then have to accept the situation that they must keep out of the Community, with consequences for foreign policy and economic policy which Mr. MacMillan only hinted at in his announcement to the House of Commons last Monday. Alternatively and more probably delicate and prolonged negotiations will need to be undertaken. It may well be that very many months will pass before matters come sufficiently to a head for a proposition to be put before Parliament. In the meantime we hope that the Government will see to it that the people of this country are better informed that they are at present

about almost every aspect of the project. For unquestionably too high a price should not be paid for entry into the Community. Indeed we rather wonder whether any price might not be too high. Ever since the days of the first Elizabeth the United Kingdom has been in, but not fully of, Europe. Its people have looked to the world at large rather than primarily to Europe for trade. The British attitude is quite well epitomised by the term we use for a few of our pages each week, Continental Section, an expression inexplicable to Americans who regard the U.K. as part of the Continent of Europe. To remain out of the Community may mean that the U.K. becomes a small and less important nation than it has been for the last three centuries or so. But small nations need not have low standards of living. Switzerland and Sweden have living standards amongst the highest in Europe. Moreover loss of its individual political importance is something the U.K. must suffer whether or not it joins the Community. Indeed the loss might be higher within the Community, which will probably lead eventually to the creation of a United States of Europe, than without. If Britain is to join, in fact, it must do so, we feel, without damage to its world-wide affiliations with Commonwealth and with other nations outside Europe. Indeed were these affiliations damaged the rôle which Britain could play within the Community would be of lesser value to that Community.

BRITAIN'S ECONOMIC SITUATION

The fact, revealed by the Prime Minister last Monday, that the United Kingdom is to make formal application to join the European Economic Community explains to some extent the decisions of the Chancellor of the Exchequer announced on Tuesday of last week and commented upon in last week's issue. Taken by themselves the Chancellor's proposals seemed to many, as the chorus of criticism revealed, unsatisfactory on several counts. Primarily this country's problem is to raise the annual value of its exports so as to cover the cost of its imports. But there was no action taken by the Chancellor which could be seen to be actively encouraging to exporting firms or which might induce other firms to look for export markets. But in the context of the approach of the U.K. to the European Economic Community Mr. Lloyd's "little budget" can be seen to make better sense. If negotiations are to open in September it is obviously desirable not only that Britain's economy shall be in fact strong, but that it shall be seen to be strong. The measures which are to be adopted are those which are likely to impress the world's economists. The medicine to be given to the patient is much the same as that given to him before and it has always brought relief. It can safely be assumed that it will do so again.

Nevertheless the medicine is debilitating stuff. It cures by cutting back consumption into line with production instead of expanding production into line with demand. Much more interesting than the actions of the Chancellor are the ideas of the Council on Prices, Productivity and Incomes recently reconstituted with its original terms of reference under the chairmanship of Lord Heyworth. They are expressed in its fourth report which we briefly review elsewhere in this issue. It calls amongst other things for the publication more quickly of fuller economic statistics, especially about earnings, orders and changes of stocks. It points out firmly that the U.K. is a high tariff nation, not a low tariff one as so many people suppose, and that high tariffs tend to make it easier and more profitable to sell in the home market than to export. They tend also to make it easier for firms to pass on higher costs due to wage increases to the consumer on the home market who, having more money in his pocket, is well able to pay, than to consumers abroad. Finally methods of encouraging raised productivity and of adjusting the rise in demand and the rise in money incomes are discussed. The last paragraph is worth quoting in full. "The primary responsibility for policy and action must rest with the Government. We have indicated in this Chapter the three lines along which we ourselves believe progress towards economic growth with price stability can be made. We have found no device at home or abroad that would provide an automatic, impersonal adjustment; the proposals which would help most all depend in some measure on people's willingness to work with them, and there is none known to us that would be at once acceptable to all the parties concerned. Yet such opposition does not stem from real self-interest. The sources of opposition are, rather, a strong attachment to principles learned the hard way in a world very different from the one we live in; failure to realise what we should gain if we were able to avoid inflation; and the fear that self-discipline will only leave the way open to others. At the heart of the problem of inflation under full employment is a frame of mind."

CREDIBILITY OF THE DETERRENT

Our naval correspondent in this week's issue calls attention to the strengthening of our anti-submarine forces now in progress and provided for in the current Navy Estimates, to deal with possible attacks on the sea communications. We have also seen in recent weeks in Kuwait a striking demonstration of the Navy's power rapidly to intervene in an emergency. The first British troops to land were the men of No. 42 Royal Marine Commando who were brought with their heavy vehicles and equipment over 1000 miles to Kuwait by the carrier "Bulwark" in two days. Joined by two frigates and five tank landing vessels, this force did much to help in discouraging and deterring any move to overcome the sheikdom. All this is very satisfactory as the emergency this country is likely to be faced with in the future is a brush fire campaign developing into a more serious conflict, in which the Soviet policy of controlling the underdeveloped countries may force one or more of the N.A.T.O. nations to engage. Britain and the Western European nations have held this opinion for the past two or three years, and the United States Government and people now show signs of coming round to this view. Included in the immense defence budget of 42.7 billion dollars, recently passed by the House of Representatives — the biggest defence budget since World War II — are 1 billion dollars more than earmarked last year for new weapons and techniques required for fighting limited wars.

Nations go to war to gain some definite objective — military, political or economic — and not to commit suicide. None the less, though this is fully realised in the United States, her Government and military leaders, who have the main responsibility for preventing a thermo-nuclear war, are by no means convinced of the stability of the present thermo-nuclear balance which is generally believed to make the idea of major aggression irrational or even insane. They believe there is too little awareness of the distinction between a "strike-first" capability and a "strike-second" capability or of the implications of this distinction on the "atomic-stalemate"

theory. Deterrence, in their view, is not automatic or assured, but will require sustained and intelligent effort in choosing and maintaining the best types of alternative deterrents and the best ways of protecting them. It must be clear to an aggressor that he too will suffer catastrophic damage in the event of his aggression. This is indeed the reason for the very large sums allocated in the recently passed budget for the provision of the two solid-fuel deterrent missiles "Minuteman" and "Polaris." Reliance at present is still being placed on manned bombers and the intercontinental liquid-fuel "Atlas" and "Titan" missiles. But the United States defence budget makes clear that the future of strategic deterrence lies in mobile bases. Nearly 2 billion dollars is to be spent on doubling the annual production of "Polaris" submarines from five to ten and no fewer than twenty-nine of these vessels are to be in service by 1964 instead of 1967, as proposed by President Eisenhower.

It is indeed fortunate that the United States, in addition to maintaining very large conventional forces, has the financial and material resources to devote to the construction and upkeep of these large numbers of rockets, manned bombers and submarines for deterrent purposes. But, as already emphasised in these columns — and since then also in the House of Lords during a debate on the current Navy Estimates early in July — Britain might well assist the United States Navy in manning and operating some of the "Polaris" submarines, either now, or in 1970 when the effectiveness of the V-bomber seems open to doubt. The United States Navy will find increasing difficulty — indeed is already finding much difficulty — in providing the highly skilled personnel required for these vessels. The Royal Navy on the other hand should have no difficulty in providing crews for a substantial number of the forty-five vessels of this type to be built in accordance with United States plans. Not only would this be a sensible and logical way of conserving the limited resources for the defence of Britain and the other N.A.T.O. allies. But Britain as a great N.A.T.O. power would be taking her fair share in the essential provision of a weapon which is most unlikely to be used while at the same time increasing the conventional forces and weapons required for the kind of conflicts she may have to face in the future.

WHAT IS TRAFFIC ENGINEERING?

In an article in this issue Brigadier Lloyd discusses traffic engineering. In particular he asks whether those who practise traffic engineering really are engineers. Support for the idea that they are not comes from the fact that many of those who contribute to discussions at the Institution of Civil Engineers are not engineers. But though Brigadier Lloyd sets out to show that traffic engineers are mal-named engineers readers may remain unconvinced. What he does argue more convincingly is first that they are not highway engineers and secondly that highway engineers arrogate too much to themselves in supposing that traffic engineering is a somewhat minor exercise in road design easily within their competence. But even if they are not highway engineers the men who study every aspect of traffic flow (of pedestrians as well as of vehicles it should be noted) may nevertheless still be engineers. Can they not be regarded, for instance, as those who control and operate the roads to the best advantage much as the engineers of the Central Electricity Generating Board control and operate generators and transmission plant and the flow of electricity, without being concerned with the design or manufacture of that plant or the uses to which electricity is put? May it not also be true that Brigadier Lloyd underestimates the amount of erudition required of a traffic engineer? It strikes us, for example, that no one has yet really tried to work out in a scientific way methods of easing congestion in London's existing streets, taken as a whole, and that the work of doing so might invite the use of very advanced statistical theory and the carrying out of really scientific observations of traffic flows both of vehicles and pedestrians.

If traffic engineering really is not engineering then its spiritual home cannot continue to be the Institution of Civil Engineers. At the moment that body provides regular opportunities for discussion and it admits all and sundry who are interested to those discussions. That rather free and easy arrangement may perhaps reflect some doubt among the Council of the Institution as to the status of traffic engineering. The tendency seems to be to regard it as a minor branch of highway engineering. But the admission to the meetings of so many people who are certainly not engineers may indicate a doubt amongst some members of Council as to whether the subject is really one for engineers at all. If traffic engineering is not an engineering subject then traffic "engineers" will need either to found their own society to look after their interests or to find some other society under whose wing they can hope to prosper. Traffic engineering might, for example, be regarded as a branch of town planning, itself a branch of architecture, so that an appropriate body might be the Royal Institute of British Architects. But if it is engineering, and we think it is, does it not need to gain recognition in its own right as an important specialisation within civil engineering? For there is a growing need in every city of this country for the services of traffic engineers; but it is at present difficult to discern any very satisfactory source of supply. That situation is likely to persist, we fear, until such time as the status of a traffic engineer has become properly established. What is traffic engineering?

The Engineer—100 Years Ago (AUGUST 2, 1861).

"Manchester Association for the Prevention of Steam-Boiler Explosions"

"At the last ordinary monthly meeting, held on Tuesday last, Mr. L. E. Fletcher, chief engineer, presented his monthly report, from which we have been furnished with the following extracts: 'During the past month 239 visits have been made, 669 boilers as well as 442 engines have been examined, and the following defects discovered: Fracture, 7; corrosion, 11; safety valves out of order, 12; water gauges, ditto, 11; pressure gauges, ditto, 5; feed apparatus, ditto, 4; blow-off cocks, ditto, 9; fusible plugs, ditto, 1; furnaces out of shape, 19; over pressure, 7 (dangerous); deficiency of water, 2; boilers without safety valves, 1 (dangerous); total, 99 (8 dangerous); boilers without glass water gauges, 17; without blow-off cocks, 20; without pressure gauges, 5; without feed back pressure valves, 54. During the last month three explosions have come to my knowledge, each attended with loss of life. In neither case, however, have the boilers been under the inspection of this association, nor, I believe, under that of any other."

"The constant occurrence of explosions from weak places in the plates, entirely unsuspected, and only ascertained by a *post mortem* examination, as it were, shows the imperative necessity for laying bare the plates of all boilers which have been in work for any length of time, and having a faithful and most searching examination made of them on both surfaces."

A Locomotive History—The "Atlantic"

By E. C. POULTNEY, O.B.E.

No. II—(*Continued from page* 128, *July* 28)

British "Atlantics"

TURNING now to the history of the "Atlantic" and its development on British railways, interest must inevitably be largely centred on those introduced on the Great Northern Railway by H. A. Ivatt, who designed and built at Doncaster the first British "Atlantic" type locomotive, thus introducing a new type for main line passenger services. Up to the time when Ivatt succeeded Patrick Stirling, the principal passenger services had been successfully worked by the well-known "Stirling" single-driver locomotives of either the 4–2–2 or 2–2–2 type, though the period of their usefulness, if not already reached, was fast approaching. Heavier trains were making demands on the locomotives then available which frequently required the use of assistant engines, though, rather strangely, the first passenger engines introduced under the new régime were two different designs of the 4–4–0 type, both, moreover, of moderate proportions. These came in 1896 and 1897, those in the latter year being, however, an improvement on the former design on account of their improved boiler capacity.

The First British "Atlantic"

H. A. Ivatt's locomotive, No. 990, the first British "Atlantic" (Figs. 13 and 14), came out early in 1898, one year after those of the larger 4–4–0 type previously mentioned. The new locomotive aroused much interest, the design being distinctly novel compared with usual practice at the time; nevertheless, it inaugurated a type that successfully worked the important main line passenger services on the Great Northern for many years.

Further, though the Gresley "Pacifics," first appearing in 1922, ultimately took over the more important express workings, it is a fact worth recording that Ivatt's later and larger series of "Atlantic" long continued to play their part, so much so that they were not ultimately retired from active service till the end of 1950, some forty-eight years since the first of the type left the Doncaster shops, surely a fitting tribute to the design and the designer. Turning to No. 990, it may be said that, as a new design, it was conservative and, moreover, was a perfectly logical development of Patrick Stirling's famous 4–2–2 type "8ft singles," of which in a sense it might be said to be but a four-coupled version, sharing with these earlier locomotives that simplicity of construction so characteristic of Stirling's many Great Northern designs. In potential power the 4–4–2 wheel plan provided means for added boiler power, especially when compared with the 4–4–0 designs of 1896–97, which will be fully realised from the following comparative particulars relating to No. 990 and the second and larger 1897 series of the 4–4–0 locomotives.

	4–4–0, 1897	4–4–2, 1898
Cylinders, diameter and stroke, in	17½ × 26	18½ × 24
Coupled wheels, diameter, in ...	79½	79½
Steam, pressure, lb per square inch	170	175
Heating surfaces, square feet :		
Tubes	1130	1302
Firebox...	120	137
Total	1250	1439
Grate area, square feet	20·5	24·5
Engine, weight, tons	47½	60
Tractive force, lb (maximum) ...	14,600	15,690

From the above, it will be seen that with an increase in tractive force of 8 per cent the new design has fifteen per cent more heating surface combined with 20 per cent more grate area when compared with Ivatt's larger 4–4–0 locomotives in 1897. Making now a brief reference to the details of the new engines, attention is directed to the modest cylinder dimensions and to the valves, which were of the semi-balanced design with open backs for the purpose of allowing a very free exhaust. The Stephenson valve gear operated the valves direct, being arranged inside the engine frames in the manner common at that period. The coupling rod pins, as applied to the main driving wheels, were so made that the throw of the coupling rods was 23in, whereas that of the outer portion of the pins upon which the connecting rod worked had a throw of 24in, obtained by turning them eccentrically in relation to the part taking the coupling rods. Ivatt used a four-wheeled leading bogie with the American pattern of swing link control for the lateral movement and a wheel base of 6ft 3in unequally divided, the distances between the centre of the leading axle and the bogie centre pin being 3ft 3in and between the trailing axle and the bogie centre pin, 3ft. The trailing single axle had outside journal boxes in outside supplementary framing, thus adding to the stability of the engine and at the same time keeping the journal bearings clear of the firebox—a good feature. The engine, No. 990, ran for some time before any further locomotives of the same type were built, until, in 1900, a further ten were turned out after No. 990 had proved to be a satisfactory and capable engine.

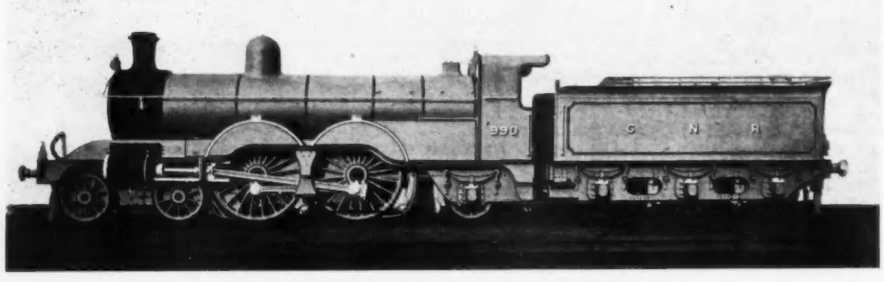


Fig. 13—Ivatt's first "Atlantic," No. 990, 1898

Ivatt's "Atlantic" No. 251

The success of the 990 class "Atlantics" led to a further step being made in 1902, resulting in the building of an enlarged design basically the same as the original of 1898, but fitted with a much larger boiler of greatly increased steaming capacity. While, as already stated, the "990" class were somewhat conservative in their proportions, the new design, on the other hand, exploited more fully the fundamental possibilities offered by the "Atlantic" wheel arrangement by being given a large boiler with a wide firebox having an outside width of 6ft 9in. The total heating surface amounted to the respectable figure of 2500 square feet, of which 141 square feet was contributed by the firebox, which had a grate area of 30·9 square feet. Apart from the new boiler, this revised design differed but little from No. 990, having, in fact, the same framing, wheel spacing and dimensions and also cylinders of the same size. From their advent in 1902 up to 1922, when the first "Pacific" came out, these No. 251 class engines worked with success the East Coast Joint Services of passenger trains; perhaps this was more particularly the case after superheating was introduced in 1910, though at the same time they have always done good work in fast passenger traffic on the Great Northern. The first of these celebrated engines, No. 251, is illustrated in Fig. 15 which shows the engine as originally built in 1902. In Fig. 16 the large boiler is seen mounted on the frames: it gives an excellent idea of the form of the wide firebox. As later superheated, these larger "Atlantics" were illustrated in THE ENGINEER of August 12, 1960.

The smaller and earlier series of these "Atlantics" is illustrated by the photographs of engine No. 990, both as originally

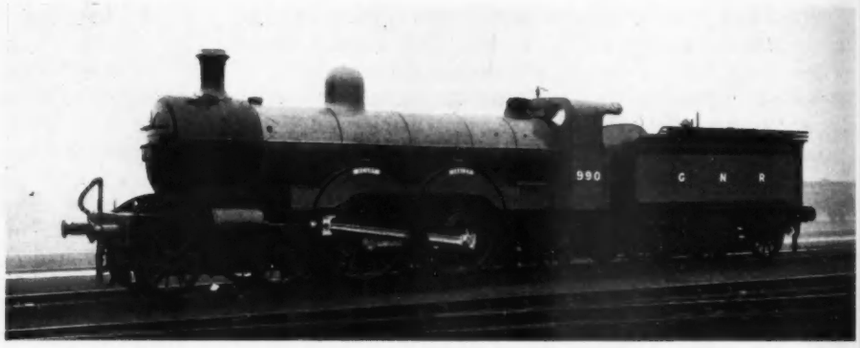


Fig. 14—The locomotive No. 990 as rebuilt in 1909 with a superheater-fitted boiler and larger cylinders

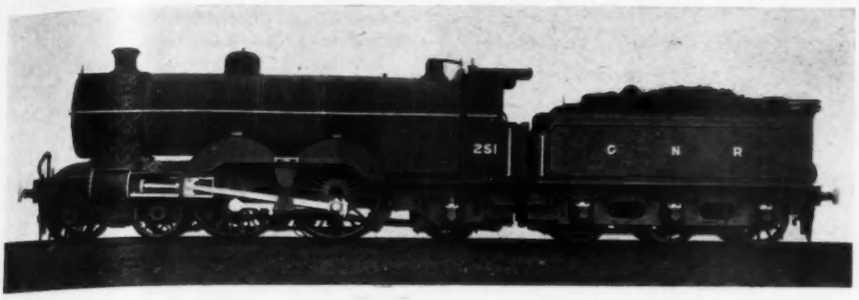


Fig. 15—The first of Ivatt's large "Atlantics," engine No. 251, 1902

built and after being reconstructed with a new boiler fitted with a superheater, together with new and larger cylinders (Figs. 13 and 14). Superheaters were first applied to these smaller engines when No. 899 was rebuilt in 1909. Normally, piston valves were fitted when superheaters were introduced, though there were certain exceptions to this practice.

The following tabulation gives for comparison the leading dimensions of the "990" and "251" class engines when superheated.

G.N.R. SUPERHEATER "ATLANTICS"

	No. 988	No. 1452
Engine Class		
Cylinders, diameter and stroke, in...	20×24	20×24
Coupled wheels, diameter, in ...	79½	79½
Boiler steam pressure, lb per square inch	170	170
Heating surfaces, square feet :		
Tubes and flues	1027	1882
Firebox...	137	140
Evaporative	1164	2022
Superheater	343	427
Combined	1507	2449
Grate area, square feet	24·5	30·9
Engine weight, tons :		
On coupled wheels	32·2	36·0
Engine	60·0	69·4
Rated tractive force, lb	17,340	17,340

W. WORSDELL'S NORTH EASTERN "ATLANTICS"

The introduction of "Atlantic" type locomotives by W. Worsdell's large "Class V" engines in 1903 was an interesting case of a four-coupled design taking the place of six-coupled locomotives of the 4–6–0 type. Up to 1899, locomotives of the 4–4–0 type had been used for the principal express passenger services, but with continuous increase in the weight of the important East Coast Joint service operating between London (King's Cross) and Edinburgh (Waverley), Worsdell turned attention to six-coupled engines, and produced in the year mentioned a design of the 4–6–0 type notable as being the first to be specifically built for passenger traffic on a British railway. The first ten of these engines had, however, rather small wheels, only 73½in in diameter, and apparently proved unsuitable for fast running, the result being that a further design similar in all important respects soon appeared, but with larger wheels, 80½in in diameter. A number of these were constructed between 1900 and 1911, and, though meeting with a certain degree of success, a further step was taken in 1903 when an entirely new design appeared in the form of a very fine example of the "Atlantic" type Class V (Fig. 17). The new engines, by having much greater boiler power than the six-coupled engines with about the same tractive effort as those having the larger 80½in drivers, were in every way more suited to requirements and as such met with considerable success in just the same way as had Ivatt's Great Northern "Atlantics" which handled the same trains as the North Eastern engines on a road not greatly different in character. With the introduction of Worsdell's 4–4–2 type locomotives in 1903, the East Coast Joint Stock passenger traffic was from then onwards, for the space of some twenty years, handled exclusively by four-coupled engines of the 4–4–2 type. It was not, in fact, till well after Grouping and the formation of the London and North Western System in 1923 that the excellent Gresley "Pacifics" monopolised the East Coast passenger workings.

Like Ivatt's larger series of "Atlantics" Worsdell's design was perhaps chiefly notable on account of the large boiler, a distinguishing feature of which was the comparatively large firebox, providing 180 square feet of heating surface, made possible by the 4–4–2 wheel arrangement allowing of a deep box with an ample volume, combined with a simple form of construction. The barrel portion, 5ft 6in diameter with 268 2in tubes, 16ft 2⅝in long between tube plates, contributed 2275 square feet of heating surface, together with the 180 square feet in the firebox, making the total up to 2455 square feet. The grate area was 27 square feet and the working steam pressure 200 lb per square inch. The large cylinders, 20in diameter with a piston stroke of 28in, had 10in piston valves inside steam chests and Stephenson's valve gear. The diameter of the coupled wheels of 82in with these cylinder dimensions and the steam pressure of 200 lb per square inch gave a maximum tractive force of 23,300 lb.

When these locomotives were first built, they had the distinction of being the heaviest in the country, with a weight, engine only, of 72 tons, of which 39 tons were on the coupled wheels. With the high maximum tractive force of 23,300 lb and 87,360 lb available for adhesion, the factor of adhesion was only 3·75, which was apt to make these engines rather inclined to slip when starting. Ivatt's engines with their smaller cylinders and lower working steam pressure had an adhesive factor of 5·1, making them more reliable, and had the further advantage of a short piston stroke of only 24in, compared with 28in for the Worsdell engines. From the balancing point of view, Ivatt's engines probably suffered less from variations in wheel loadings at high speeds, though the relative weights of the reciprocating masses and the proportion balanced would have a decided influence on any differences in this respect between these engines.

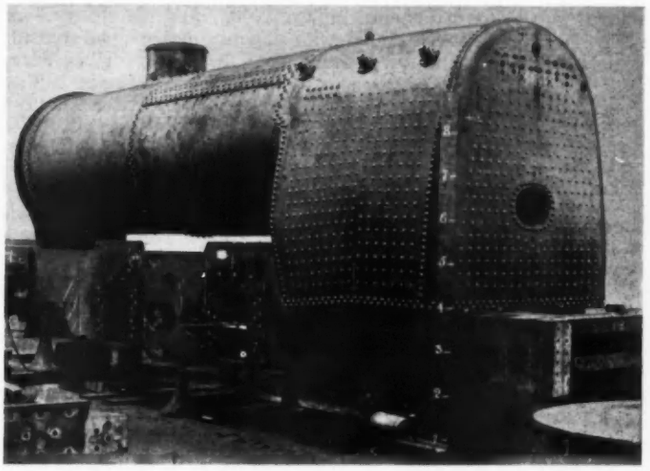


Fig. 16—Ivatt's large boiler showing the wide firebox, 251 class

Between 1904 and 1910, further "Atlantics," built at Darlington, appeared, the first of which is illustrated by the photograph of engine No. 696. They differed in certain respects from those built in 1903, principally by having modified main frames of stronger construction and 19½in cylinders in place of 20in, which, together with a lower steam pressure, 175 lb per square inch, reduced the rated tractive force from 23,300 lb to 19,380 lbs.

When first built, these engines used saturated steam, but were later superheated

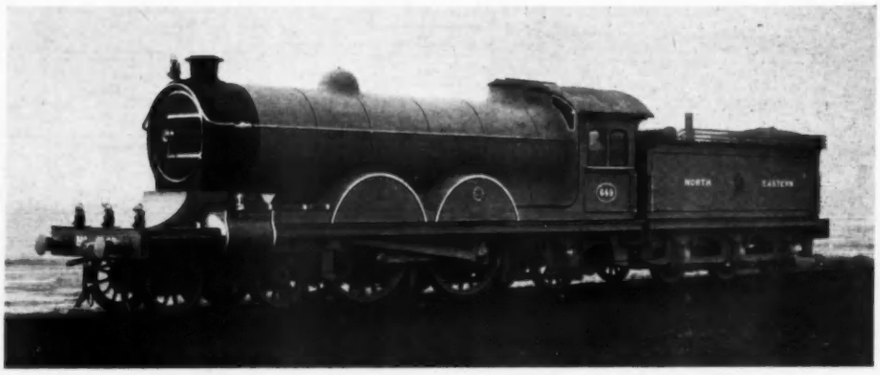


Fig. 17—W. Worsdell's "Atlantic" type locomotive, North Eastern Railway, 1903

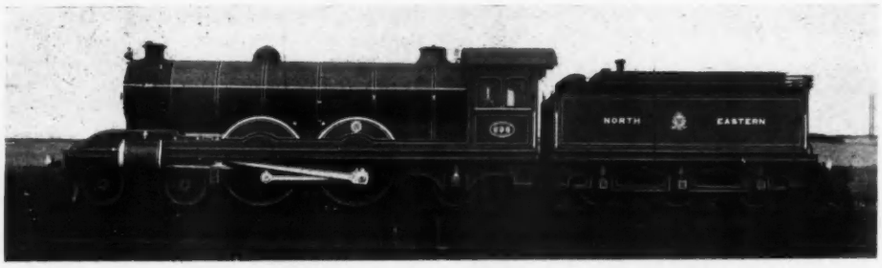


Fig. 18—Worsdell's modified " Atlantic " design, first built 1904

and the cylinders were then restored to the original dimensions of 20in by 28in, when, with the reduced steam pressure of 175 lb per square inch, the tractive effort became 20,250 lb, giving with 89,376 lb, 40·2 tons, on the coupled wheels, an adhesive factor of 4·39.

The accompanying drawing (Fig. 19) shows this design, and the weights given apply to the locomotives when fitted with a twenty-four-element superheater. The boilers with respect to their general design and dimensions were as for the original engines built in 1903.

The boilers when first fitted with superheaters had heating surfaces as follows :

Tubes, 134 2in diameter...	1138 square feet
Flues, twenty-four 5¼in diameter...	534·5 square feet
Firebox	185·0 square feet
Total evaporative	1857·5 square feet
Superheater	392 square feet
Combined...	2149·5 square feet

In the case of some of these engines, the superheater heating surface was increased to 437 square feet due to having elements of larger diameter.

When Sir Nigel Gresley read his Institution of Mechanical Engineers' paper on Three-Cylinder Locomotives in 1895, the heating surface particulars differed from those given above on account of the number of tubes being reduced from 134 to ninety in the case of some of these boilers. The total evaporative heating surfaces were then given as being 1483·4 square feet. The diameter of the cylinders was also given as 19½in. These dimensions applied to the two-cylinder 4–4–2 engines used for the comparative trials with 4–4–2 type three-cylinder engines having identical boilers.

The Great Central " Atlantics "

Coincident with the appearance of the Worsdell "Atlantics" on the North Eastern in 1903, Beyer, Peacock & Company, built four experimental locomotives to J. G. Robinson's designs to determine the relative suitability of the 4–4–2 and 4–6–0 types for express passenger service on the Great Central Railway. These engines were all of similar dimensions, Nos. 192 and 194 being of the 4–4–2 type and Nos. 195 and 196 six-coupled engines of the 4–6–0 type. All the engines had 81in driving wheels and boilers of the same dimensions and a common working steam pressure of 180 lb per square inch. The total heating surface, all evaporative, was 1911 square feet and the grate area 26 square feet. The cylinders of the same design for all engines, but for the purpose of determining the most suitable dimensions one engine of each type had 19in by 26in and the others 19½in by 26in cylinders. Both designs had outside cylinders so that the 4–4–2 engines were true " Atlantics." The 4–6–0 engine had a weight of 67·75 tons, of which 52·5 were on the coupled wheels, and the " Atlantics " weighed 66·8 tons with 37 tons available for adhesion. Descriptions with illustrations of the 4–6–0 and the 4–4–2 locomotives will be found in The Engineer of May 6 and June 10, 1904.

The " Atlantics " were found to be the more suitable for working the passenger service at that period with the result that a further number were built, as follows : Nos. 263–267, five engines, Beyer, Peacock & Company, 1904 (Fig. 20); Nos. 1083–1094, fourteen engines, North British Locomotive Company, 1905, and Nos. 260–262, 258, 360–363, eight engines, Gorton Works, 1906. Those built by the North British Locomotive Company had a boiler working pressure of 200 lb per square inch ; all the others had a steam pressure of 180 lb per square inch, the standard at that time. In all cases the outside cylinders were 19in by 26in with slide valves operated direct by Stephenson's valve gear inside the main frames ; in like manner, the coupled wheels were of the same size, 81in diameter. The engine weight was 71·9 tons with 37 tons on the coupled wheels. There were some small differences in the heating surfaces ; for the Gorton Works locomotives the total was 1972 square feet and the grate area 26·3 square feet and for the remainder the heating surfaces were 1931 square feet and the grate area 26 square feet. Firebox heating surfaces were in all cases practically the same, the differences being, therefore, in the tubular heating surfaces.

During later years, most, if not all, of these " Atlantics " were rebuilt with superheaters. When rebuilt, new cylinders 21in diameter with the same stroke of 26in were fitted and 10in piston valves were substituted for the original slide valves. Otherwise the valve gear and motion parts were retained as originally applied.

These " Atlantics " enjoyed a good reputation in main line passenger duties for many years and, as a design, they had many admirers.

G. J. Churchward's " Atlantics," Great Western Railway

The " Atlantic " type locomotives built by H. A. Ivatt and W. Worsdell were what may be called clear-cut " Atlantic " designs ; that is to say, they were in no way tied up with any similar class with a different wheel arrangement, as was the case with the engines of this type as developed on the Great Central and again on the Great Western, on which line the first 4–4–2 was, in point of fact, a converted 4–6–0 (Fig. 21). In neither case, therefore, could the " Atlantic " wheel plan be exploited, as was the case in North America or at Doncaster.

On the Great Western the design would seem to have originated almost by accident rather than design, unless we could be assured the experimental building of an " Atlantic " would have taken place if no 4–4–2 type French-built four-cylinder compound engines had ever been placed in traffic. The situation as between the six-coupled ten-wheeled engines and the 4–4–2 " Atlantic " locomotives was perhaps rather peculiar. The 4–6–0 was designed definitely as a six-coupled engine with all the weight required and perhaps even more for the tractive force available ; even so, when converted to the 4–4–2 type by the elimination of the trailing pair of drivers, the relatively high tractive effort of 23,090 lb became really too high for the weight of 39 tons then available for adhesion.

The foregoing briefly outlines the events leading to the introduction of the " Atlantic " type on the Great Western ; at the same time, however, some further remarks may be necessary respecting the 4–6–0 type from which the 4–4–2 locomotives were derived. The original Churchward standard 4–6–0 engine appeared early in 1903, followed later in the same year by a further engine of the same design and construction, differing only by having a higher working steam pressure of 225 lb per square inch, resulting in an increased maximum tractive effort of 23,090 lb, compared with 20,530 for the earlier engine, which had

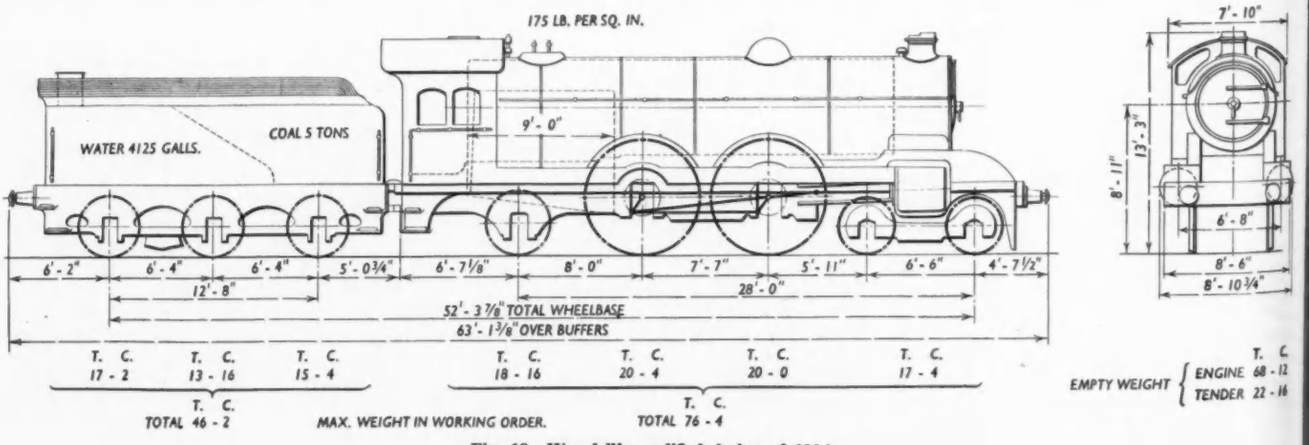


Fig. 19—Worsdell's modified design of 1904

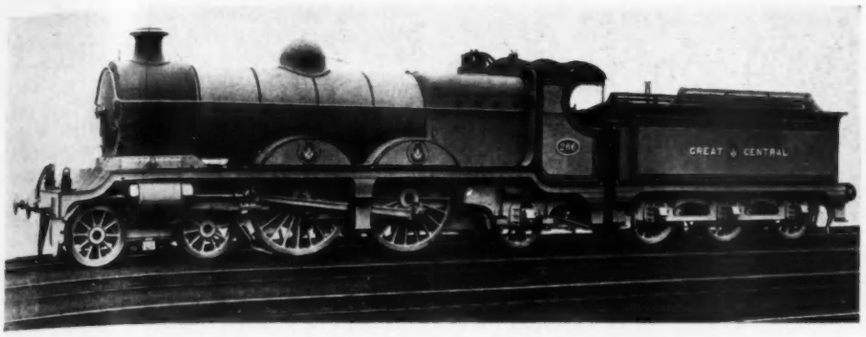


Fig. 20—J. G. Robinson's "Atlantic" locomotive for the Great Central Railway, 1904–1906

boiler steam pressure of 200 lb per square inch. The purpose of raising the steam pressure in the case of the later locomotive was to enable it to compete more favourably with the French compound engine No. 102, "La France," having a steam pressure of 227 lb per square inch. Churchward's engine named "Albion," numbered 171, was later in 1904 converted to have the 4–4–2 wheel arrangement in order to be in this respect like the French engine, also of the 4–4–2 type. As a six-coupled engine, "Albion" carried 54·2 tons on the coupled wheels, thereby providing an adhesive factor of 5·24, which, when the trailing coupled wheels were eliminated, reduced the weight available for adhesion to 39 tons, so reducing the factor of adhesion to the rather low value of 3·78. For a two-cylinder locomotive, this weight/tractive effort ratio was manifestly insufficient, so that, although "Albion," and others like it subsequently, could and did do very good work, they were apt no doubt to be somewhat slippery on occasion, which accounted for all being converted to the 4–6–0 type as originally conceived. In actual practice, No. 171 was in certain respects a remarkable engine. Trials indicated that at a running speed of 70 miles per hour, as much as 1045 horse-power at the tender drawbar was recorded, corresponding to a pull of 2·5 tons, or 6·4 per cent, of the weight on the coupled wheels of 39 tons, assuming that, when these trials were made, the engine was as altered to the 4–4–2 wheel arrangement. If, on the other hand, "Albion" then had six coupled wheels, this value would be reduced to 4·6 per cent.

At 30 m.p.h., the pull recorded was 6·3 tons, giving these percentages as 16·1 and 11·6 respectively. While wheel rims, or rail tractive efforts, would, of course, be higher than those registered at the tender drawbar, it is, nevertheless, clear that the adhesive weight of 39 tons would at both speeds be ample to resist slipping. The accompanying graph has been developed to show how the adhesive weight tractive efforts ratios increase in value with increasing speeds.

The traction characteristic shown is as recorded by the test plant dynamometer, therefore, corresponding to the tractive effort measured at the rails; in other words, it is the true "rail" tractive effort. The curve drawn in the lower part of the graph shows how for a given static load on the driving wheels the adhesive factor increases in value from 4·34, in this particular case, to 13·6 at a running speed of 75 m.p.h. The "rail" tractive effort is the maximum attainable, and is governed by the boiler steam supply and the cylinder demand. In other works, the traction characteristic shown is a combined boiler and cylinder curve.

When considering slipping tendencies at speed, it is also necessary to take into account the effect of the centrifugal force set up by the overbalance added to take care of the reciprocating parts of the motion. At speed, this adds to or subtracts from the static load carried by the drivers and for any given amount by weight of overbalance at a given speed will be more accentuated in the case of an engine having a long piston stroke.

The Great Central and the Great Western "Atlantics" may be said to have been developed from a 4–6–0 design, retaining in each case the same boiler, which had, therefore, a somewhat shallow firebox, the depth being limited by the rear coupled axle of the 4–6–0 locomotives. Such being the case, it is evident that the opportunity offered by the 4–4–2 wheel arrangement for the provision of a large firebox with large heating surfaces and increased volume could not be realised. This is a distinct disadvantage of this method of experimenting with locomotives of the 4–6–0 and 4–4–2 types. On the other hand, the fact that in both instances the respective 4–6–0 and 4–4–2 locomotives handled the same trains did indicate that six-coupled locomotives were frequently used when a four-coupled engine with equal boiler capacity could equally well do the work.

The fact that the Great Western "Atlantics" were subsequently converted to the six-coupled type can hardly be held as being a contradiction to this statement. All that had been done was to obtain an engine rather more reliable under adverse rail conditions, which might conceivably have been attained by simply fitting a modern form of sanding arrangement.

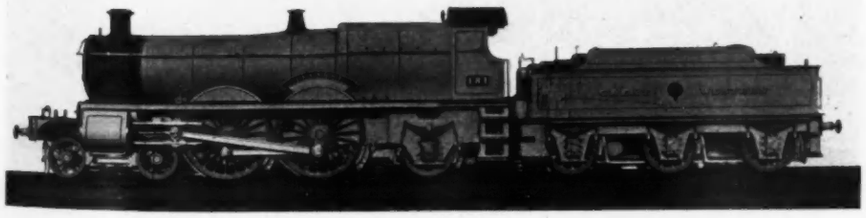
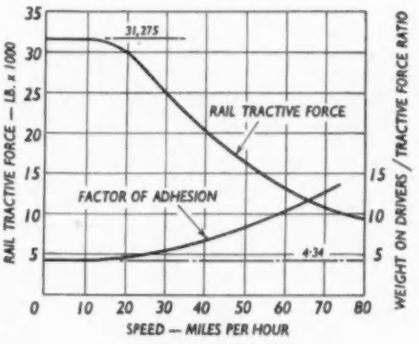


Fig. 21—Great Western "Atlantic" type locomotive "Ivanhoe," No. 181, built 1904

The writer does not happen to have any records of the performance of these engines put into traffic 1904–5 except some information given by C. Rouse-Marten writing in THE ENGINEER relating to the performance of "Albion" working trains of 300 tons from Paddington to Bristol; in one case as a 4–6–0 and in another instance when running as a 4–4–2. The two journeys were, however, too dissimilar because of slow downs for signals to be of much value; all that can be said is that there seemed little to choose between the runs in question. (See THE ENGINEER, July 7, 1905.) In THE ENGINEER of March 23, 1906, there will be found a graph showing a dynamometer car record of a trip from Paddington to Bristol with a 337 ton train showing the recorded drawbar horse-powers at a speed of 60 m.p.h. from Paddington to Swindon. The "cut-offs" used varied from 15 to 23 per cent. At the latter admission rate, 1100 horse-power


RAIL TRACTIVE FORCE — LB. x 1000
WEIGHT ON DRIVERS / TRACTIVE FORCE RATIO
31,275
RAIL TRACTIVE FORCE
FACTOR OF ADHESION
4·34
SPEED — MILES PER HOUR
0 10 20 30 40 50 60 70 80
5 10 15 20 25 30 35

Cylinders 23½in by 26in.
Driving wheels 80in diameter.
Rated tractive force 31275 lb.
Steam pressure 205 lb per square inch.
Weight on drivers 136,000 lb.
Factor of adhesion 4·34.

Fig. 23—Variation of adhesive weight/tractive force ratio with speed in miles per hour

was recorded at 60 m.p.h., thus indicating a drawbar pull of 6900 lb 3·09 tons, equal to 5·7 per cent of the 54 tons available for adhesion. The cylinder performance will be recognised as outstanding.

(To be concluded)

BEAMA Electronics Board

THE BEAMA Council has established an Electronics Board to represent that part of the membership directly concerned with electronic engineering. This new Board will act for the Council on matters of broad policy in this field, and it will provide liaison with Government departments and other associations on policy matters affecting the electronic industry. The initial membership of the board is as follows: Mr. Leon Bagrit (Elliott Brothers), chairman; Mr. O. W. Humphreys (G.E.C.), vice-chairman; Mr E B Banks (English Electric); Mr W. S. Steel (A.E.I.); Mr. Sebastian de Ferranti (Ferranti, Ltd.); Mr. C. Metcalfe (E.M.I.). The chairman of the BEAMA Industrial Electronic Equipment Section, at present Mr. W. Gregson (Ferranti, Ltd.), is also a member of the Board. These arrangements are designed to provide within the framework of the BEAMA an organisation to safeguard the interests of British manufacturers concerned with electronic engineering, but it is not intended to assume on behalf of members responsibility for other sectors of the electronic engineering industry, e.g. telecommunications and components which are already dealt with by existing associations. The Board will, however, co-operate with the governing bodies of such other associations whenever policy matters affecting the electronic industry as a whole call for representations at top level.

Precise Control of 3000-ton Forging Press

Although the production of heavy steel forgings is the work of a relatively small branch of the steel industry, the equipment and techniques used have been studied intensively, and some plant of advanced design is now in use. The design of the new 3000-ton forging press at Walter Somers, Ltd., is a complete departure from the traditional in several respects, especially in the matter of control. Maintenance of forging size and accuracy are much easier with the new press than with conventional presses, and a greater range of forgings can be made.

FOR nearly a century, Walter Somers, Ltd., Haywood Forge, Halesowen, near Birmingham, has been making forgings, first of iron and then of steel, and has a number of presses to deal with the different sizes and varieties of its products, which range from die blocks to heavy forgings for which a steel ingot weighing 60 tons or more is the basis.

For the production of heavy and medium forgings the company has had in use for a number of years three presses, an 800-ton, a 1500-ton and a 3000-ton, all of the "push-down" type, powered by steam-hydraulic intensifiers and controlled by hydraulic valves and hand levers, the latter being grouped at a convenient point for the operator. All three presses were old, and the 3000-ton machine in particular was in need of extensive repairs if it was to continue in use. Similarly, the boiler plant supplying the steam for the presses was in need of repair. A preliminary estimate showed that by dispensing with steam as a power source and using electricity there would be reduction in total power cost of more than 8 to 1 : conversion to electric drive was therefore an obvious first step.

The question then was whether to convert the existing presses or to buy a new press or presses which would be capable of doing all the work of the department. To convert the existing presses to electrically-powered water or oil hydraulic operation would have been difficult—especially in the case of the 3000-ton machine—and all the presses were too old to justify large conversion expenses. It was obvious that the 3000-ton press, at least, should be replaced. If this was done, there was the further question of what should happen to the other two, smaller presses? A very large range of forgings is produced by the department, and one of the difficulties in making a relatively small forging on a large conventional press is that the degree of control on the press stroke is insufficiently close to work at anything like an economic speed. With a large press the operator would have to work with extreme care on a small forging to avoid over-forging. Hence the three conventional presses, each with its own range of work.

The solution to this problem lay in the use of thickness control on a large press, which would enable the operator to pre-set the stroke of the press accurately from his control desk instead of having to "feel" the ram down to its required position. A form of thickness control has operated successfully on a smaller press in another of the Company's departments for some time, and it was felt that this mechanism could be adapted without difficulty for use on the large press.

It was therefore decided that one press of 3000 tons capacity, suitably designed and equipped with accurate thickness control, would be able to do all the work formerly done by three machines. Three different types of press were considered ; the conventional four column "push-down," the inverted or "pull-down" press with four columns, and the inverted press with two columns. Of these, the conventional four column was ruled out because of its height in the first of the positions considered for it, and in any case it did not give very good access to the tool area. Even in the position finally chosen, where there was adequate headroom for either the push-down or the inverted press, the push-down only offered two advantages compared with the design chosen—a two column inverted press. It would have needed shallower and therefore cheaper foundations, and the moving weight would have been less. Both these advantages were outweighed by those offered by the two column inverted press.

The principal advantages of the two-column inverted press are :

1. Its overall height is less than half that of a conventional press. It is in this case 15ft high, instead of 34ft, which makes it possible for the shop cranes to carry loads over the top.

2. There is better access to the press tools, and it is never necessary to thread a mandrel bar or other tool through the columns.

3. The operator's view of the work in hand is much better.

4. The press is more stable because its point of support is very close to its centre of gravity, and it is practicable to use much longer column guides.

5. There are no oil pipes or controls above ground, where they might be damaged by the cranes, or by loads swinging.

6. If an oil pipe should break or leak, there is no possibility of oil falling on a hot forging, and therefore the danger of fire is reduced.

7. Since the more delicate parts of the control and operating equipment are not above ground level, it is easy to group them in a suitable position and enclose them in an area supplied with clean, filtered air under pressure. Maintenance problems are thus simplified.

8. The extensive foundations—the only disadvantage of the inverted press—have been put to good use in the present instance. By a relatively small extension of the excavation it has been possible to provide an underground chamber to house all the hydraulic pumping and electrical supply equipment adjacent to the control gear, where it is out of harm's way.

Press Specification

The press built to replace the three existing ones is an oil-hydraulic two-column, three-stage, drawdown press with three hydraulic working cylinders in line. It can be used with the centre cylinder only, when it has a maximum effort of 1000 tons and a pressing speed of 7·5in per second ; with the two outer cylinders, giving a thrust of 2000 tons and a pressing speed of 3·75in per second ; or with all three cylinders, when it has thrust of 3000 tons and a pressing speed of 2·5in per second. Approach speed is 9in per second and the return speed 14in per second. All three power cylinders are identical, having a ram diameter of 25½in and a stroke of 7ft. For lifting the crossheads during the return stroke there are two return cylinders, each with a piston diameter of 13½in and a maximum stroke of 10ft. Hydraulic balance is provided, with a nitrogen-on-oil accumulator working at about 2000 lb per square inch, to give a balancing force of about 160 tons ; this leaves sufficient out-of-balance weight for the top crosshead to fall freely on the approach stroke. The balance cylinders each have a piston 13½in diameter, with a stroke of 10ft. The press columns are set at 14ft centres on a centre-line at an angle of 30 deg. to the centre-line of the sliding anvil, that is, the main access line for the work from either side of the press. By this off-setting of the columns the operator is given a completely clear view of the work under the press. There is 12ft of daylight between the top moving crosshead and the sliding anvil plates, and the press stroke is 7ft. As this single press will deal with the whole output of the department, which formerly needed three machines, the ingot heating capacity has had to be augmented, and the new press will be fed from ten furnaces.

The anvil is carried on hydraulically-powered sliding plates, enabling the complete bottom tooling with the forging in position to be moved a total distance of 14ft, or 7ft each side of the working centre line. All the hydraulic equipment and sliding gear is below floor level. In addition, the press has, at an angle of 25 deg. to the work approach centre-line, tool change gear which enables a complete set of tools to be changed in a matter of minutes.

The complete tool change gear is in two parts, one on each side of the press, and both on a common centre-line. On the tool change side proper is a hydraulic cylinder, below floor-level, with a stroke of 12ft and a hydraulically-operated pin engaging in holes in a drag bar. This drag bar is used to push out the tools (the top one resting on the bottom one) and pull in a fresh pair. The tools taken out of the press can be lifted off the change gear by the shop crane, or they can be pushed to the opposite side of the press from the change gear, where tool transfer equipment, consisting of a cable-hauled carriage, operating over a stroke of 23ft, is used to remove them well clear of the press to a point where they can either be stored temporarily for re-use, or removed by crane as required. All the movements of both the tool change gear and the transfer gear are remotely controlled, and to assist in the quick change of tools the top tools and tool holder are held in the crosshead by spring retainers which can be hydraulically released from the operator's desk.

Power and Control

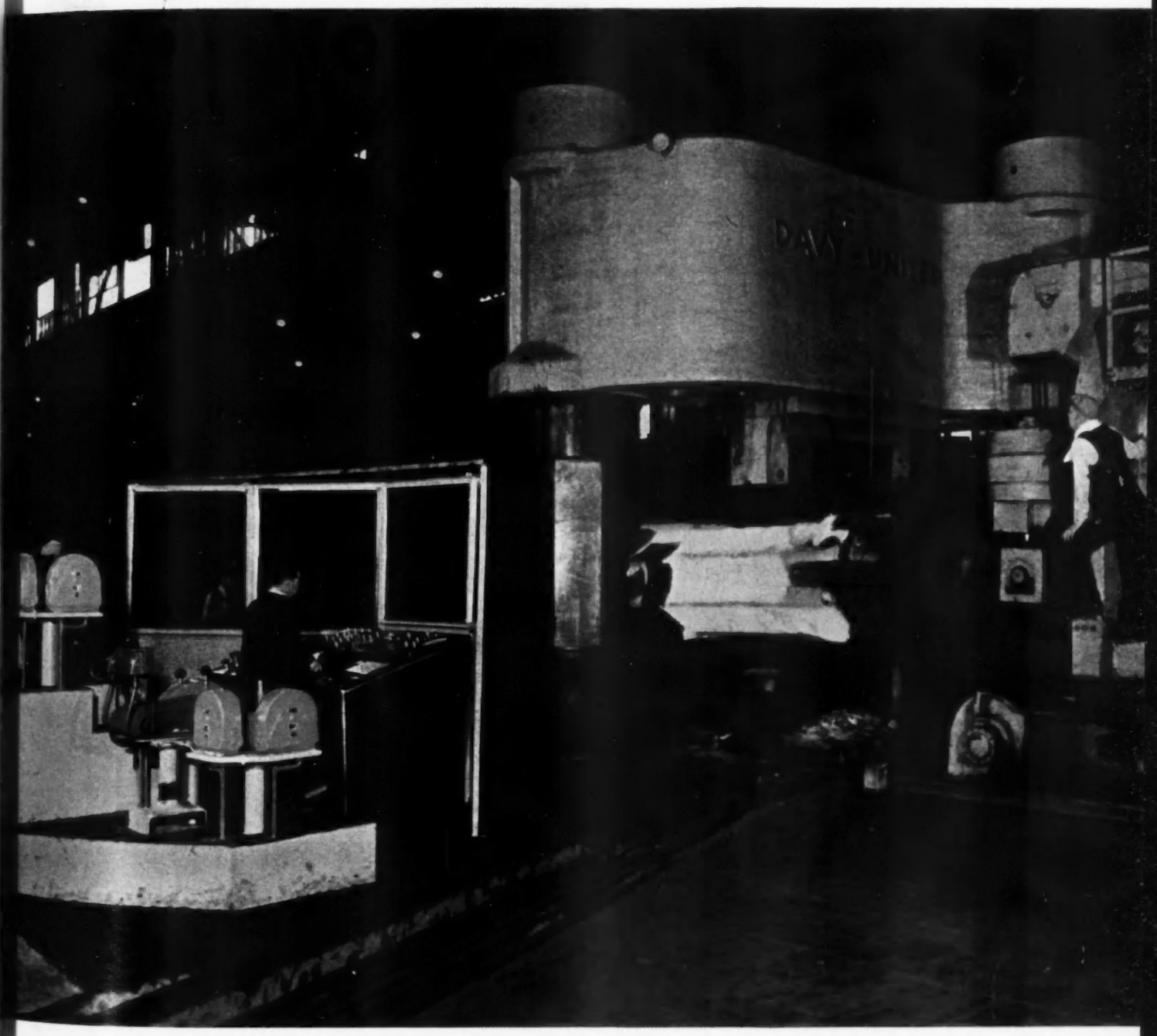
A special design of hydraulic pump was developed for the press to give the required power and oil output while retaining reasonable overall dimensions. This design, having been tested under accelerated service conditions and found to answer all the demands made on it, was adopted as the basic power unit. Six pumps are installed on the lower of three floors built into the

Precise Control of 3000-ton Forging Press

In the illustrations which follow, many of the unusual features of the press are clearly visible. In particular, the low overall height, the good accessibility to the working area and the simplicity of the layout are obvious. The illustration BELOW shows the start of forging operations on a large ingot, which is suspended between the manipulator (on the right) and the overhead electric crane which has brought it from the furnace. At the control position (left foreground), the press operator is seen in his normal working position with, on his left, the driver of the overhead crane supporting the far end of the ingot. Immediately in front of the press operator is an unoccupied crane control position; this is used at certain times, but not during the operation shown. There is a further crane control position on the left, off the picture and this, again, is not in use for the particular job in hand.

The manipulator, which is only partly visible in the illustration, is driven independently, and is capable of advancing and withdrawing the ingot and rotating it as required. In this work it is assisted by the chain rotating gear on the overhead crane, which can be operated in unison with the manipulator. In the foreground of the illustration the track of the tool transfer gear can be seen. This is used, in conjunction with the tool change gear (hidden by the forging), to effect a quick change of tools when necessary, and the layout of the press is particularly adaptable for the purpose.

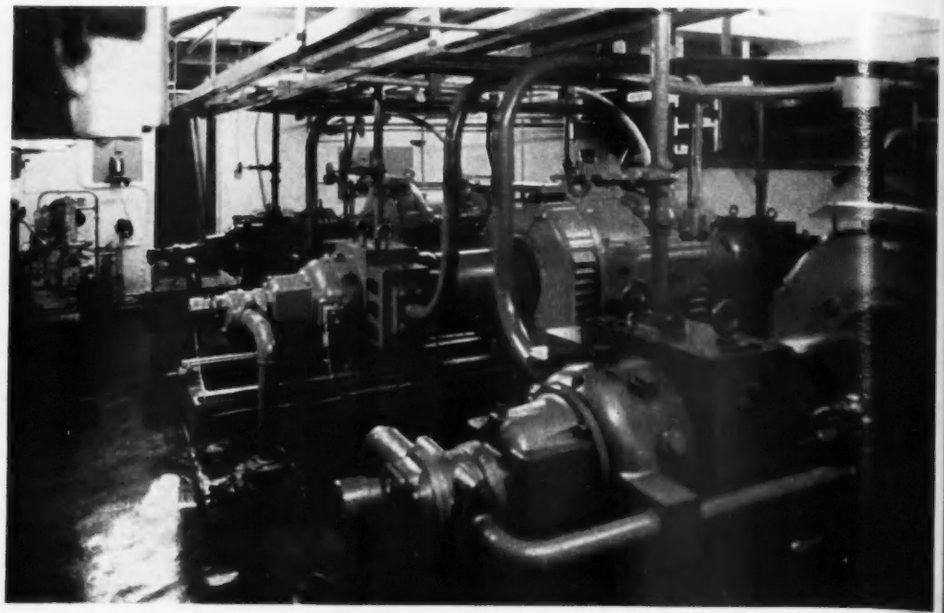
The forging in the process of being made in the press is, in this instance, a propeller shaft for a ship, though of course the press is adaptable for a very large variety of different types and sizes of forgings ; that is, in fact, one of its most important features. No still picture can convey properly the ease with which the press is controlled. In the stage shown BELOW the process calls for repeated top tool strokes as the ingot is moved along and rotated, and the operator, having set his press stroke, has merely to keep the control handle depressed ; ram movement is automatic until the handle is released.

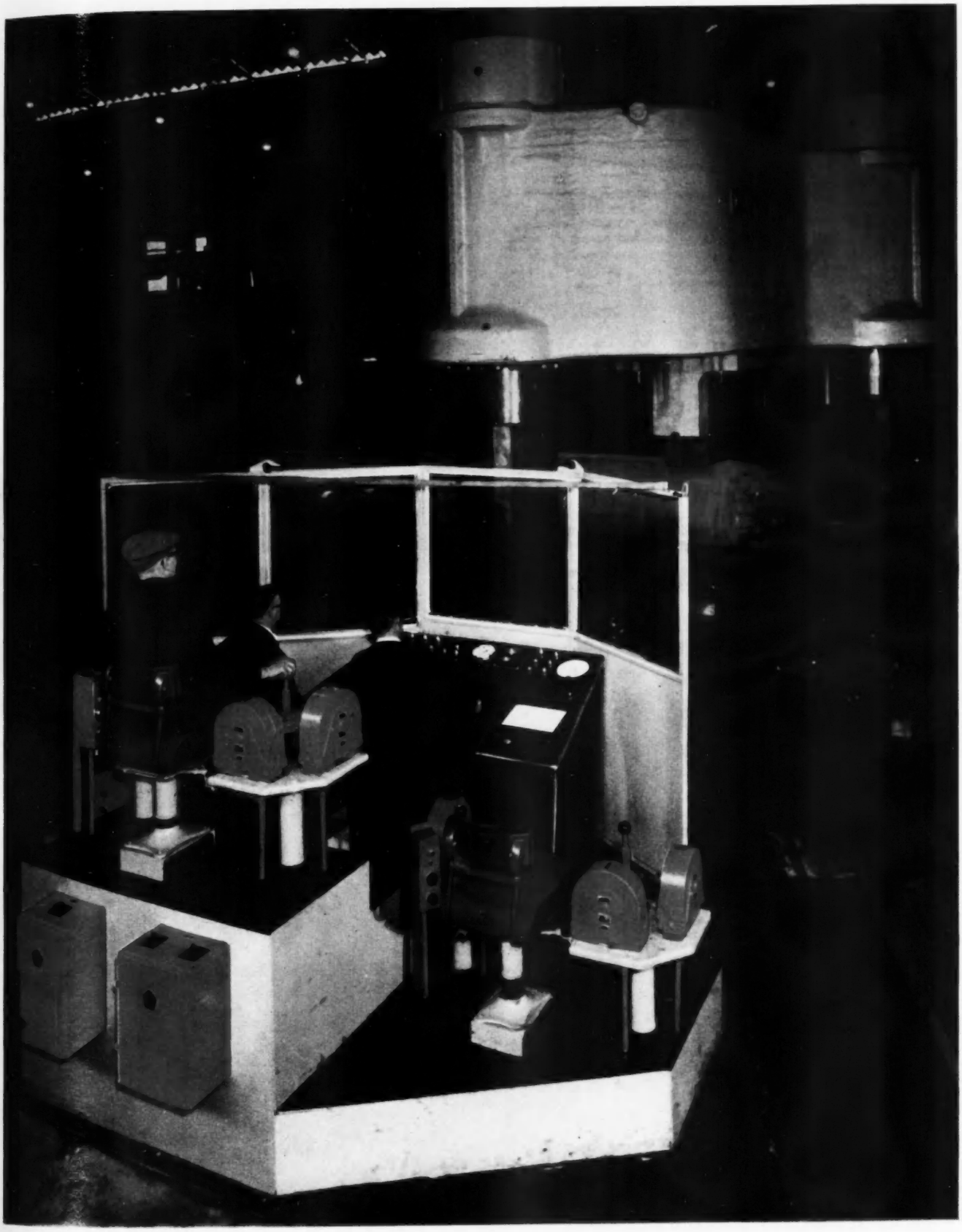


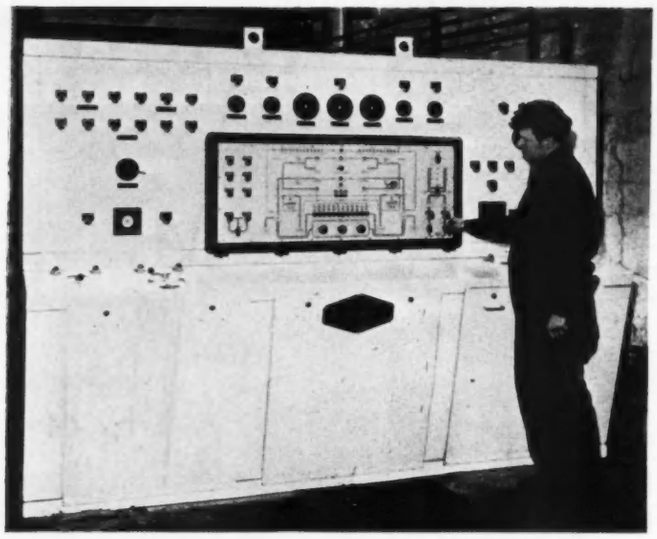
The hydraulic pumps (RIGHT) are housed at the bottom of the underground extension to the press foundations, where they are out of the way and are safely protected from accidental damage by an ingot or forging being manipulated under the press.

BELOW is a view of the back of the press, showing the forging a stage nearer to completion. In this view the crane chain supporting the forging can be seen clearly, while the chain rotating gear is also visible in front of the press crosshead. In the background the manipulator is just visible. Between the columns of the press the anvil sliding gear, carrying the bottom tool can be seen. This enables an ingot to be placed by the crane on the bottom tool and moved by hydraulic power into the working position.

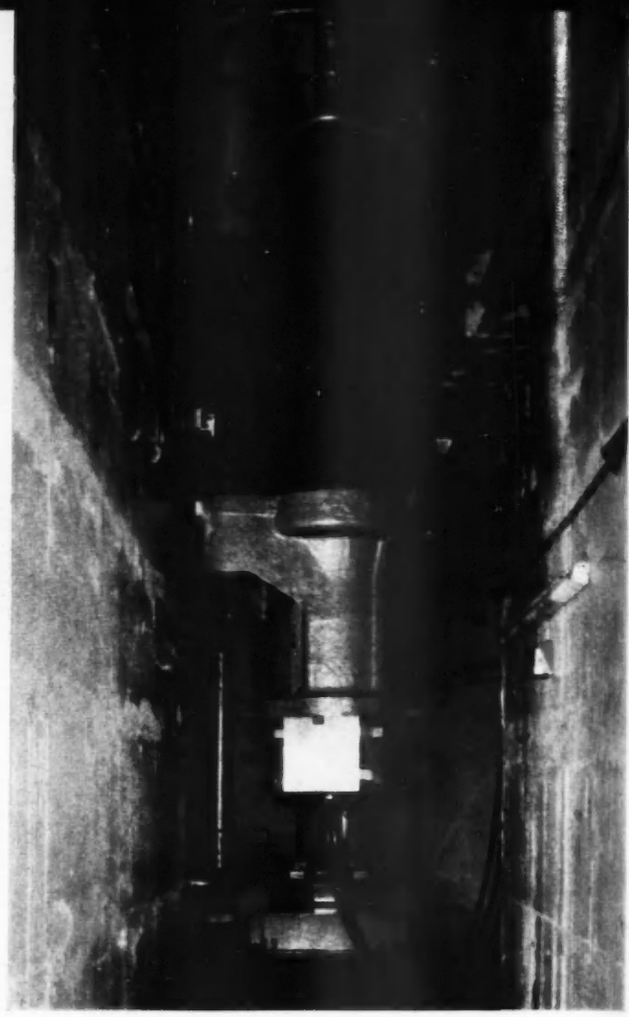
In the illustration on the FACING PAGE the control positions are shown clearly, and the ingot is seen to have been drawn out further.



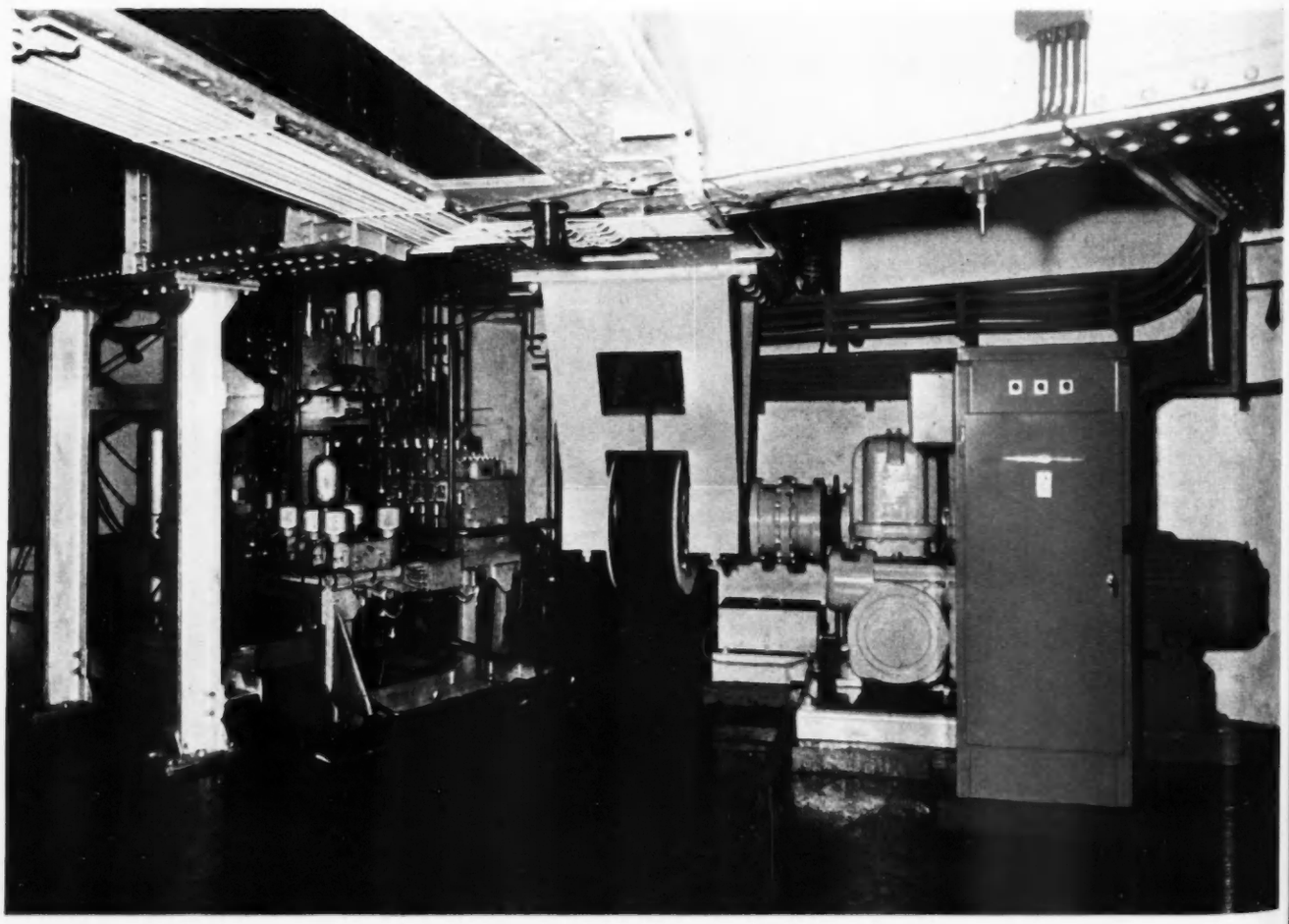




ABOVE is the maintenance panel, with the operator going through the switching sequence to prove the various circuits. RIGHT is a view from the bottom of the foundations, looking up to the bottom crosshead of the press.

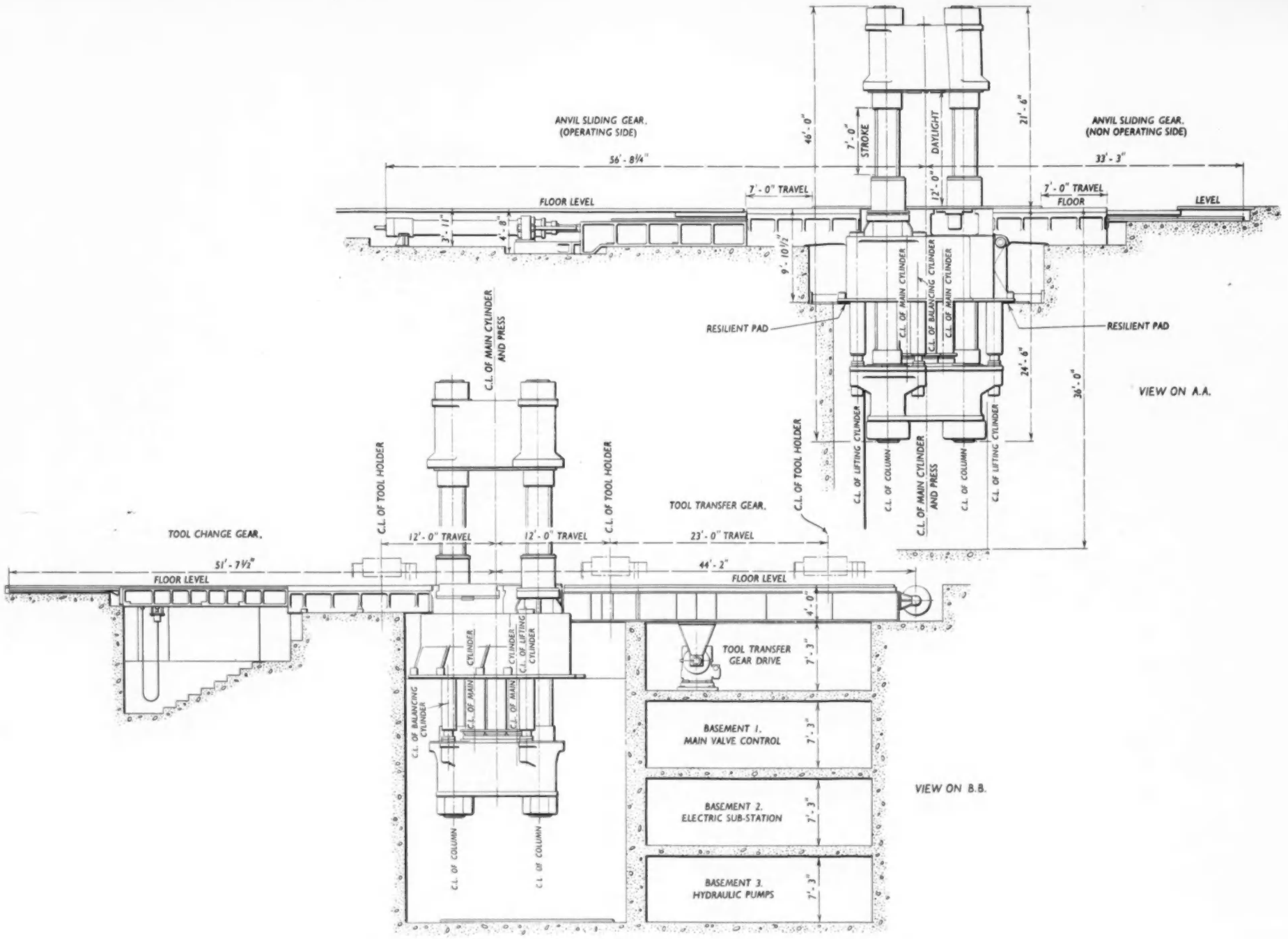


BELOW is seen part of the first underground floor, with the hydraulic valve gear on the left and the drive motor and winch for the tool transfer gear on the right.

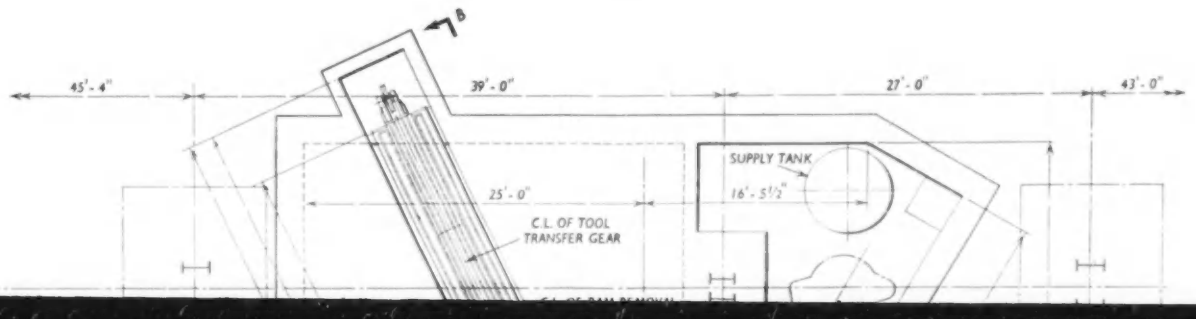


PRECISE CONTROL OF 3000-TON FORGING PRESS

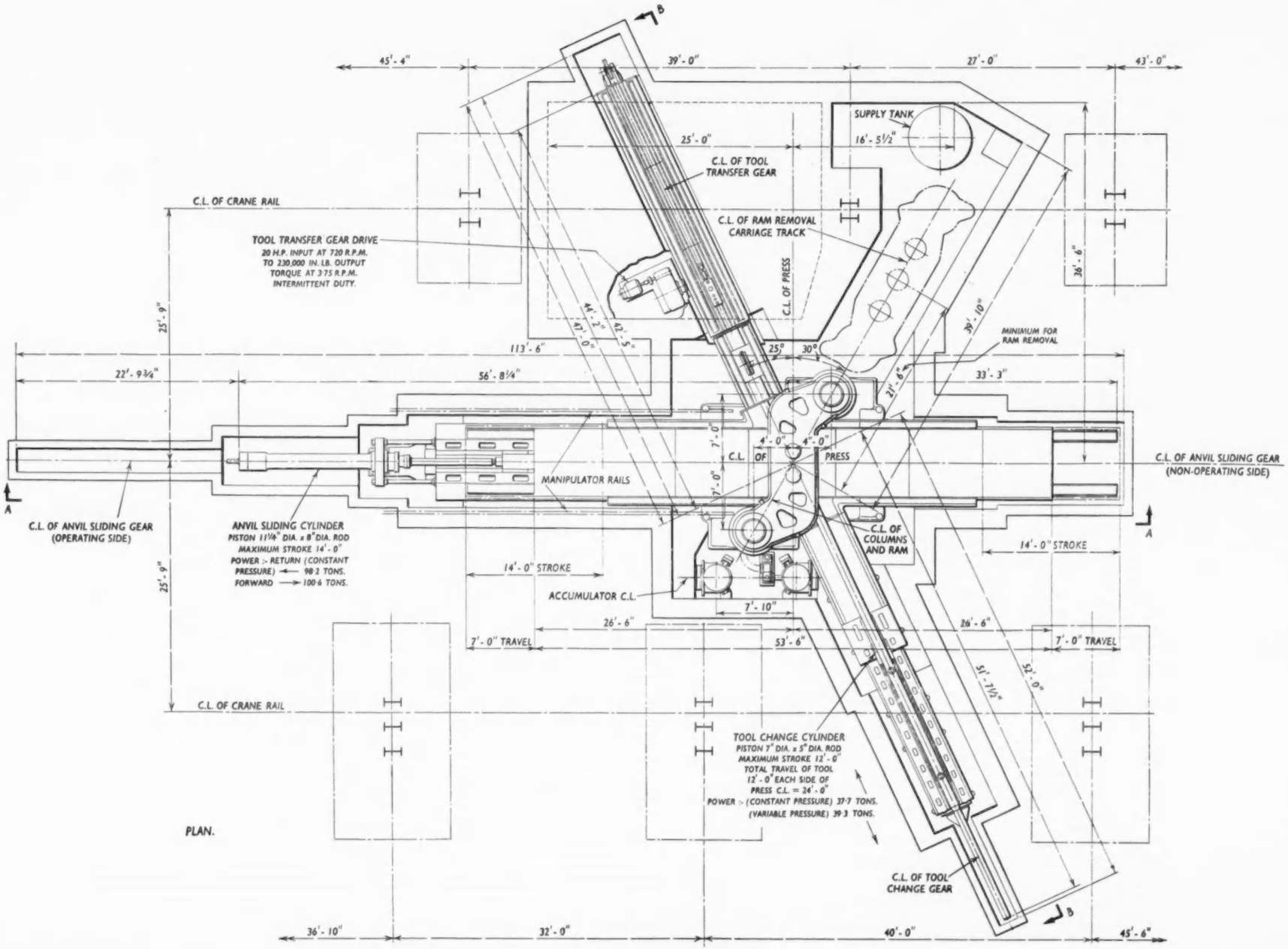
PRECISE CONTROL OF 3000-TON FORGING PRESS



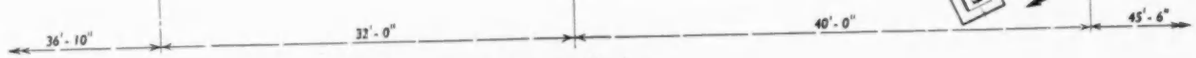
Elevation of press on anvil centre line (above) and tool change centre line (below)



Elevation of press on anvil centre line (above) and tool change centre line (below)

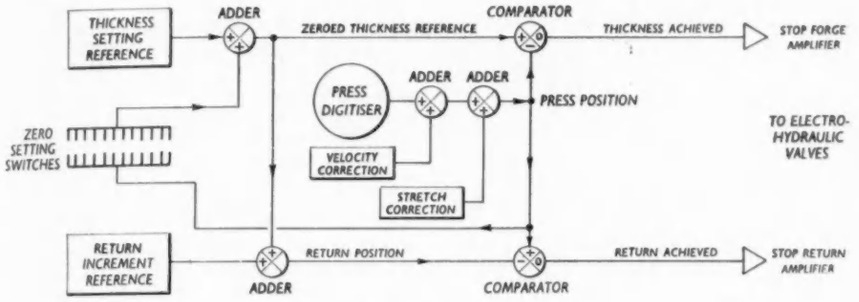


Plan of press and auxiliaries



Plan of press and auxiliaries

press foundations. They are driven in pairs by motors of 500 nominal h.p. each, with a peak horsepower of 1000 at a working pressure of 4500 lb per square inch, and the pumps each deliver 150 gallons of oil per minute when running at 1500 r.p.m. To simplify maintenance all the pumps are fitted with replaceable sleeves, suction and delivery valves and seats, and virtually any component can be removed and replaced independently with the pump *in situ*. On the upper of the three underground floors is the hydraulic valve gear for controlling the press (the middle floor houses the electrical equipment). By means of this valve gear the press operator is enabled to select the tonnage at which the press will work, and to control the actual stroking of the crosshead and tools. Tonnage selection is by means of a lever on the control desk, which brings the inner cylinder alone, the two outer ones, or all three, into operation according to whether a force of 1000, 2000 or 3000 tons is required. Control of the press movement is by a single lever on the operator's desk ; this has a neutral, a "forge" and a "return" position, and switches in pumps progressively to give faster speeds the further it is moved from the neutral position. A pre-filling tank, maintained at about 50 lb per square inch pressure, ensures that the cylinders are filled with oil during the rapid free approach part of the stroke. The pre-filling valves close automatically when the tool comes into contact with the work and the main power pumps then take over.



Thickness control logic diagram

Precise control of the press is exercised by the thickness control equipment (illustrated in the logic diagram herewith), which makes it possible ;

1. For the press itself to be used as an accurate and effective measuring device, and for the operator to be assured of the exact thickness of the forging after each stroke.

2. For every stroke to be made at full speed, since reversal is made automatically at the exact time necessary to avoid over-forging. With manual control the operator has to slow down the press towards the end of each stroke to avoid over-forging.

3. For a large tool to be used on small work, as the control fixes the penetration of the tool into the work, and the operator does not have to judge his cut-off point according to the resistance of the forging.

The thickness control not only limits the distance between the tools at the end of the stroke to the dimension pre-set by the operator, it also limits the length of the return stroke (again to a pre-set distance), so preventing waste of time. In addition, it controls the stroking speed by means of a pre-set dwell at the top of the return stroke. This enables the operator to time his automatic stroke to suit the equipment manipulating the forging under the press.

To exercise the degree of control needed, the thickness control has to carry out several functions simultaneously. It has to measure, continuously, the distance between the moving crosshead and a fixed reference point, to compare this distance continuously with a dimension pre-set by the operator, and to stop the press and reverse it when the set point is reached. It must make allowances for the velocity of the moving parts and for the stretch of the press under load. Provision must also be made for re-setting the zero reference point when the tools are changed during a forging run.

Setting of the thickness control by the press operator is by means of a series of manually operated dials, marked in inches and fractions of an inch down to $\frac{1}{32}$in. These figures are converted by the mechanism into binary numbers for use as one of the two references from which the thickness control operates. The control mechanism is duplicated, which provides a safeguard against possible failure, and also, since the two control equipments are operated from opposite sides of the lower moving crosshead, near the column, enables an indication of eccentric loading to be given. If this eccentric loading should exceed a predetermined amount, the control equipment could be used to stop the press.

Each of the control actuators consists, essentially, of a digitiser mounted on the fixed middle crosshead of the press, and connected to the lower moving crosshead. These provide continuous references to the position of the moving crosshead, and velocity and stretch corrections are added automatically. The figures thus produced are fed into comparators, in which they are compared continuously with the manually-set thickness setting reference (corrected to zero according to the tools in use), or with the return position reference, according to whether the press crosshead is moving on the down, working, stroke, or the up, return, stroke. Immediately the digitiser and setting references coincide, an electronic signal is given to the hydraulic control via high-speed solenoid pilot valves, and the movement of the crosshead stops. If it is on the down stroke, it is reversed ; if it is returning it stops and is held for the pre-set delay period. The pilot valves were specially designed to give the extremely rapid response necessary, which should be as nearly instantaneous as possible and is, in fact, 4 milliseconds.

Operation

One of the objects in designing the press control gear was to make its operation as simple as possible, and to this end the press operator is provided with a control desk having nothing more than the controls with which he is immediately concerned—tonnage selection, thickness and return setting, direction and speed of crosshead movement, and tool change gear. He is additionally provided with a visual signal for trouble of any kind, which he uses simply as an indication that he must call in the shift maintenance man. In removing from the control desk all the instruments and controls other than those actually used by the operator, the design of the press follows the modern trend which, with automatic equipment, is to separate the operating and the maintenance and testing equipment so that each worker can give his attention to the job in hand, without being distracted by matters which do not concern him, and over which he has no control anyway. The control desk is located square with the press anvil, where the operator has an uninterrupted view of the forging, and grouped around the desk—one behind and one at each side—are the control positions for three overhead cranes. These controls are of the normal type developed by B.I.S.R.A. for the ground control of overhead cranes. They control a 30-ton, a 60-ton and a 100-ton crane respectively ; no more than two cranes are in use at any one time, depending on the work being done. There is also a floor-mounted 13-ton manipulator, independently controlled, which is used with certain types of forging.

At some distance from the operating control desk a separate set of instruments and controls is mounted on what is known as the maintenance panel. By this means the shift maintenance man can ascertain that all the motors, pumps, controls and oil tanks are operating satisfactorily. The omnibus warning of some fault given to the press operator is here broken down into a diagnostic fault-finding panel, which enables the fault to be isolated and identified quickly. Duplicated electronic control units, using printed circuits, are provided, and if a fault develops in one it can be switched out while work continues on the other circuit. In the event of more serious trouble occurring, the fault-finding equipment enables a realistic assessment to be made quickly, so that a forging can be returned to the furnace, or other action can be taken as necessary.

The specification of the complete installation was drawn up by Mr. D. D. Carrington, chief engineer, Walter Somers, Ltd., and the mechanical design of the press was undertaken by Davy and United Engineering Company, Ltd., Darnall Works, Sheffield, 9, who also manufactured the three largest components. Many of the remaining mechanical parts were made by Walter Somers, Ltd. The hydraulic power equipment and thickness control gear were designed and made by Towler Brothers (Patents), Ltd., Rodley, near Leeds, and the electronic and electrical control components were supplied by Brookhirst-Igranic, Ltd., Bedford ; Towler Brothers and Brookhirst Igranic are both members of the Metal Industries Group. The hydraulic oil is B.P. Energol HL65, supplied by the Power Petroleum Company, Ltd., who market B.P. industrial lubricants in the United Kingdom.

River Severn Abstraction Scheme

The Wolverhampton County Borough Council's Water Committee and the South Staffordshire Waterworks Company have formulated a joint scheme for the abstraction of water from the River Severn. The proposed scheme will comprise an abstraction and treatment works, local storage reservoir pumping equipment, an aqueduct and a terminal service reservoir which would need to be to the south of Wolverhampton in the Sedgley Beacon area. The estimated cost is £7,344,000 and the works proposed are estimated to provide maximum output of 45 m.g.d., one-third for the corporation and the remainder for the company. Construction would be undertaken in three instalments.

Traffic Engineering Examined—Is it Engineering?

By T. I. LLOYD

FOR some years past Parliament and the Press have been promising us great benefits from traffic engineering in the relief of congestion on Britain's roads and streets. To indicate the degree of relief so far experienced—or not experienced—Sir Richard Nugent, M.P., former Joint Parliamentary Secretary to the Ministry of Transport, speaking at Birmingham University on May 12, declaimed that it was only a matter of time before the citizenry rose up in wrath at being denied the advantages of traffic engineering! He was aiming his remarks particularly at our local authorities, of whom there are 1285 with highway responsibilities, including sixty-two county and eighty-three county borough councils; only thirty-four, in the two latter categories, are employing trained traffic engineers, complained Sir Richard. But all is not conspicuously well even in the territory of the thirty-four provident authorities. Possibly what is needed is a thorough survey and overhaul of the entire system under which traffic engineering is struggling to emerge as a force in this country's affairs.

In this article, which is in the nature of a preliminary dissection of Britain's handling of "traffic engineering," the first item to come under examination will be the official, imported definition of "traffic engineering." It starts with the words: "Traffic engineering is that branch of engineering which . . . ." This is certainly a neat and convenient form of opening for the definition of any of the specialisations within the profession of engineering; but in strict logic, in this particular context, it cannot immediately be accorded any more weight than, say, "coffee is that variety of tea." For it begs the key question of whether traffic engineering is engineering; it presumes upon the validity of the name-title traffic engineering. The name has certainly been legitimised by long use; but there is no certainty that the circumstances under which it was claimed originally, and allowed, in the U.S.A., afford any guarantee of its terminological exactitude. In those days the subject was still only a minor activity and something of a mystery; moreover the avowed aim of its early practitioners was to procure for it the status of a profession; the name gained acceptance casually, and as an expedient. During the subsequent three decades, however, traffic engineering has become a widely revealed technology (if that is what it is), and it has grown vastly in importance. Accordingly the considerations that should ideally have influenced its nomenclature have now become both clearer and weightier. They merit review, if only as a form of insurance; for faulty premises are roots of trouble, and if it were to transpire that traffic engineering is engineering to only a very limited extent, or not at all, much that is wrong with the state and progress of traffic engineering in Britain might become explicable—and in due course be put right.

Is it perhaps too late, in this country, to re-open the question of whether traffic engineering is truly engineering? Our civil engineers have already taken it under their wing, as a branch of highway engineering. On the other hand they have also admitted—and welcomed—non-engineers into their Traffic Engineering Study Group, which in the two years of its existence has worthily assumed the character of a national forum, its affairs being conducted with a liberality that seems to show the council of the Institution of Civil Engineers unready to rule that finality has been reached on any aspect of the matter. The group is 800 strong, including some 230 non-members of the institution who, proportionately, seem to have played at least a due part in the group's proceedings. Accordingly the locus and status of traffic engineering can perhaps fairly be regarded as still fluid, and the legitimacy of its name-claim as a not irrevocably closed case: there may still be time to re-open these matters. In any event both sides can be presented here; for the plea that traffic engineering is indeed engineering, properly a part of highway engineering, can be put forward in the form of authoritative quotations, notably from the discussion on "The place of traffic engineering in the Institution," reported in the proceedings of the Institution of Civil Engineers, Volume 13, July, 1959.

One of the questions tabled for discussion on that occasion seemed likely to bring out all the pros and cons of traffic engineering as engineering: it began, "Should the practical training of traffic engineers include a period on works construction?" Unfortunately that particular question was scarcely discussed. Seemingly it was never intended to be, for it was tabled with an addendum that prejudged the issue and invited discussion only on the very different question of whether practical experience of traffic engineering should "be recognised as the equivalent of practical training on works as one of the basic qualifications for corporate membership of the institution." It was explained to the meeting that "there was, of course, no question of dispensing with Sections A and B"; in other words, traffic engineering might, at the most, be reckoned to round off the qualifications of a very nearly fully qualified civil engineer—which has since been conceded. Thus the discussion proceeded on the basis that whereas, of course, no traffic engineer pure and simple could ever be regarded as a civil engineer, any civil engineer was, of right, able and qualified to occupy himself in traffic engineering as a subsidiary branch of highway engineering. In fine, traffic engineering was deemed to be so purely engineering, and of such a character, that it had to be the professional province of civil engineers, not open to people drawn from other walks of life: not even, through the medium of promotion, to practitioners of technician rank.

If traffic engineering is so simple a technology that a civil engineer can master it in a few months, how is it that no other category of scientist (in the broadest sense), nor anyone else, should be rated eligible to become a traffic engineer? That question was forestalled at the Civils' meeting by Sir Herbert Manzoni when he opened the discussion; three relevant extracts from the report of his speech, in which he claimed traffic engineering as the preserve of the "properly trained civil engineer who had specialised on highways," are reproduced at (*a*), (*b*) and (*c*), with comment interposed.

(*a*). *It seemed to him that traffic engineering really dealt with the use factors which were basic to the design of highway systems.*"

This is uncontentious in so far as traffic engineering "really" deals with the use of roads, which is nowhere in dispute. Indeed the greater part of the official definition can be paraphrased, simply, "Traffic engineering deals with the use of roads."* But that is only one of the two sides of traffic engineering, argued Sir Herbert. It can be described as the operational side, as opposed to the planning and design side. His view of what the operational side entails, and the qualifications its practitioners must possess, is given in the next quotation, (*b*).

(*b*). "*Traffic surveys were necessary, and the analysis of those surveys, the consideration of methods for the control of traffic, and so on. Those things could be done just as well by someone who had had no engineering training at all . . .*"

Thus the protagonist of traffic engineering as engineering concedes that the day to day operational side of it is not engineering at all. He is content to rely upon the argument that traffic engineering has another side, which other side involves the traffic engineer in tasks of planning and design that can be undertaken only by a civil engineer. Extracts from the report of his speech, in support of this particular argument, follow at (*c*).

(*c*). "*The traffic engineer had also to consider the width of highways, the form of junctions where traffic had to weave, and possibly the siting of highways . . . . That could not be done adequately except by someone who had a sufficient knowledge of structural engineering to be able to decide the economics of a scheme on one site as against a scheme on another. The one might be in cutting the other on viaduct. The design of a junction might well involve considerations of a structural nature if it was to be built at the cheapest price and the best way. This made it essential that the traffic engineer should have a knowledge of highway engineering, or rather of the structural engineering which was involved in highway engineering.*"

The opening phrases of that extract are certainly unexceptionable in requiring the traffic engineer to be something of a geometrician, for he will be needing geometry in his day to day operational duties. But thereafter the thesis seems open to criticism as having been set *in vacuo*, almost as if the traffic engineer were the only person with any interest or responsibility in traffic matters. What, for instance, will there be left for the highway engineer to do if the traffic engineer attends to all these things?

That question is posed on the assumption that the traffic engineer and the highway engineer are not one and the same person. This assumption, self-evident though it may seem, has to be emphasised here because it conflicts outright with the historic (and current) attitude towards traffic engineering in Britain, where the subject has long been regarded as merely one more weapon in the personal armoury of any chartered civil or highway engineer, like soil mechanics or concrete mixing. A British local authority's top engineer is automatically its traffic engineer. In the authority he serves is a large one, and he is up to date in that among his multitudinous departments, deep within his highways department, there is a traffic engineering one, in which certain of his subordinates specialise in the subject, he himself will still be the arch traffic engineer: the senior traffic engineer of the department will be only one of his lowly subordinates, junior to his chief highway engineer, and

* The definition and a number of alternatives and comments that have been put forward from time to time are given in an appendix.

certainly not carrying any weight directly in local affairs. It is this system that Sir Herbert Manzoni is, in effect, defending ; under it the British highways have evolved in extent, quality and management, during the past fifty or a hundred years, and are still evolving—albeit not entirely to the satisfaction of either Sir Richard Nugent or, as he revealed in a pointedly critical speech to representatives of the Press in London last month,† after ten years as President of the Automobile Association, the Duke of Edinburgh.

To revert to the possible confusion of duties between traffic engineer and highway engineer in the extract quoted at (*c*) : it seems to be the essence of the case put forward by Sir Herbert Manzoni that the respective duties of these two functionaries are inextricably interwoven. But later in the same discussion, Mr. P. Sutcliffe, supporting and elaborating upon this basic view that the traffic engineer is first and foremost an engineer, revealed that there is, after all, a clear-cut line (or plane) of demarcation between highway and traffic engineering. He was reported as saying that " *highway engineering consisted of two wings : on the one hand road construction engineering, from the surface downwards, and on the other traffic engineering, from the surface upwards.*"

From this quotation one notes, in passing, that if traffic engineering is ultimately denied any separate existence and remains a mere component of highway engineering, it will be advisable to find a new term for highway-minus-traffic engineering : Mr. Sutcliffe's " road construction engineering " seems to depend upon too artificial a distinction. However that can wait. The concept of the road surface as the dividing plane between traffic engineering and highway engineering is surely one upon which to focus immediate attention. It appears already to have gained so large a measure of acceptance that the onus for expatiating upon it now lies with those who would dispute it. Meanwhile it can be taken as valid, gratefully beyond doubt, for it clarifies much, particularly in explicitly banishing all road construction engineering from the field of traffic engineering. Accepting it one sees that in all issues of the type instanced by Sir Herbert Manzoni—except one—the responsibilities of the traffic engineer can be separated out, leaving him with no true engineering. The one exception, involving both highway engineering and traffic engineering to varying degree, concerns the precise three-dimensional siting of any new, transposed or extended piece of the hard surface that is their dividing plane : in short, road planning. Road site planning alone, that is to say, unadulterated by design details that are the affair of the highway engineer in his capacity of road construction engineer.

Road planning is the responsibility of—whom? Plainly Sir Herbert Manzoni was seeing it as the responsibility of one engineer who is simultaneously traffic engineer, highway engineer, structural engineer and something of an economist. This view derives fairly logically from the assumption that only a civil engineer can be entrusted with traffic engineering tasks at a professional level, which in turn derives from the premise that traffic engineering is engineering. That original premise has led a long way. From it road planning has become a one-man job for the civil engineer.

To go to this extreme and make no direct use, at planning level, of the individual experience and talents of whole-time traffic engineers, involves closing one's eyes to the beneficial up-rise of traffic engineering in the counsels of other countries. What is the objection to letting traffic engineers take part in the planning of Britain? Is the aim, perhaps, to minimise argument? Let it be supposed that traffic and highway engineers (separate persons) are both engaged in one piece of road planning. It may be thought a mischief that the traffic engineer will say, " The road should go here," and the highway engineer reply, " No ; there." But in real life, in this country, there will be an immediate, " No ; elsewhere " from the town (or country) planner, and he will be followed very promptly, in like terms, by the architect, district valuer, economist, landscape architect, chief constable, medical officer of health, every property owner within range, and the Civic Trust—to mention not all of those who will feel (and be) entitled to have their say in perfecting the plan.

The only solution seems to lie in a proper recognition of what Mr. C. D. Buchanan has described as " the absolute oneness of traffic planning and building planning," leading to the recognition of planning as essentially a team job, too large for one man. Actually this view of planning (embracing, with high priority, road planning) as a team task has gained enormous impetus during the past two years ; conference after conference has endorsed it ; and it has been well exemplified, notably at Cumbernauld ; there is indeed no need to labour it here ; road planning has lost its separate identity and become (or is fast becoming) merged in a team task.

This examination had reached a point where the last shred of engineering in traffic engineering was to be looked for in planning. But planning turns out to be a team task, and the team can (and, indeed, must) always include genuine engineers in addition to its traffic engineer ; he will be required in the team as its expert on traffic, nothing more : the last vestige of an excuse for requiring traffic engineers to be engineers has disappeared.

As has been shown, under the present system Britain has had to obtain traffic engineers by weaning highway engineers away from their normal employment into this professionally subordinate (or suppressed) occupation. The trouble is that few have come across, and most of them only temporarily ; the inducements are scanty and the work can perhaps prove unsatisfying to a man who has chosen for his life career " the art of directing the great sources of power in nature for the use and convenience of man " and has accordingly been trained to be " essentially a creator " as Professor A. J. Francis put it in his recent article (THE ENGINEER, May 26, page 848). Contrastingly it is as the operator of something the civil engineer creates that the traffic engineer functions. However, operation also has its attractions as a career, and there is no reason to despair of raising the requisite army of traffic engineers for Britain once recruiting ceases to be limited to the one narrow professional field of civil engineering ; traffic holds a fascination for many people : indeed it sometimes seems that there are 50,000,000 amateur traffic engineers in Britain!

Before ever there can be an army there must be an authorised establishment for it, furnishing an adequate career structure for the entrants. Virtually nothing of the sort exists at present. With only thirty-four local authorities and a handful of contracting and consulting firms providing stable employment for traffic engineers, and no goal for them beyond, possibly, an appointment in the Ministry of Transport or at the Road Research Laboratory, it is not surprising that the army is at little more than platoon strength. No great progress can be expected, it is suggested, until there is established, on a national footing, a traffic service comparable with the many existing Government services that function throughout the length and breadth of the country under a system of partial delegation to local authorities.

This idea of traffic engineering as a public service was perhaps in Sir Richard Nugent's mind when he spoke of a popular uprising. It seems an idea worth pursuing both of itself and, here in this article, as a vehicle for the factors that remain to be examined. The primary rôle of the traffic engineer is to champion the cause of ordinary men, women and children, awheel or afoot ; to fight their battles for them and procure the roads, pavements and parks necessary for a good life in the current era of civilisation. At present, in this matter, the public have no champions except, rarely, on the political front, which is no place to hammer out any essentially technical problem. If Sir Richard Nugent is right the public will soon begin to vociferate for the creation of this new public service. One notes that it would provide a very worthwhile, rewarding form of employment, requiring some dedication of its personnel, which promises well for their morale : they could constitute a *corps d'élite*—an army being perhaps more than is required.

The difficulties, or resistance, likely to be met in setting up this new service will be interesting to weigh. Since many municipal traffic engineering tasks are currently farmed out to private firms, it seems that there are some chief municipal engineers who will be glad to be relieved of traffic engineering, and will welcome, as a colleague of equal standing with themselves, the new local head of the new service. It will be essential for him to be of this rank not only in order to give the service a career structure attractive to men of ambition, and in order to give the local council an executive official directly responsible to themselves for traffic efficiency, but also because of the special creator-operator relationship, already mentioned, between highway engineer and traffic engineer. To enlarge upon this : since the operators of civil engineering products are in effect (if not actually) the customers, it will be for the traffic engineer to specify what he wants of the highway engineer and do his best to get it, subject to the final verdict of his council. Moreover it will on occasion be necessary, in the public interest, for the traffic engineer to keep the local highway engineering department up to the mark, through the medium of criticism at least, more particularly in regard to the quality of the road surface that is their mutual concern. This will be a new departure indeed. The *status quo*, be it noted, virtually preserved British highway engineering from all really expert criticism—until the Duke of Edinburgh broke silence. Incidentally much of his criticism (e.g. one-way systems, signposting, and speed limits) would have fallen upon the traffic engineering service had there been one, and, equally, had there been a traffic engineering service, the things that exasperated him would have been eliminated long ago ; his speech can be interpreted as a severe indictment of the present system under which traffic engineering plays only the rôle of Cinderella in Act 1.

Recruitment and training remain to be considered. Beyond doubt many civil engineers and others who are already experienced in traffic engineering would join the new service ; it would offer them, at last, executive employment. The existing traffic engineering

† June 21, 1961.

departments would provide a nucleus of personnel ; but the main influx could come from many directions, for the two essential requirements are merely elementary mathematics and—as Mr. John Hay, M.P., Joint Parliamentary Secretary to the Ministry of Transport, has laid down—common sense. A third could be " the common touch," for it is humanity at large, awheel and afoot, that the traffic engineer deals with, not so much the vehicles they are driving, riding or avoiding.

Apart from mathematics these qualifications are of such a nature that there is probably no knowing how a man will shape at traffic engineering until he has been on the job awhile. For this reason it is possible that in time the service would become wholly manned by those who had entered it young, at cadet or technician level, their promotion being governed by aptitude rather than academic qualifications. Since traffic engineering is essentially practical work, with little academic content, it is not a subject in which there is much scope for tuition apart from " training on the job." It has procured a place in the curriculum of a university or two through being intermingled with highway engineering and by making the most of the Poisson theory, but is hardly shaping as a subject for degree courses at British universities. Possibly, despite the undeniable fact that its practice can be something of an art, it will ultimately be voted a technology, ratifying the policy of certain colleges that already run courses in the subject. This may seem a pessimistic outlook in view of the American efforts to establish traffic engineering as a profession ; but it may be that the American effort was misguided.

Despite strenuous attempts to induce and encourage American traffic engineers to become degree men, and degree men to become traffic engineers, 35 per cent of the members of the American Institute of Traffic Engineers are not registered professional engineers. This shows clearly enough that in order to be an effective traffic engineer a man does not have to be " a professional man." Seemingly class distinctions will be unnecessary in the British " trade, profession or calling " of traffic engineering. Whichever of those three one cares to call it, and whether its citadel is an institution, institute or union, the fact will remain that, as is found to be the case in every walk of life, its status will depend solely on the stature of those who engage in it. To draw the right men into traffic engineering, in the right numbers, within an effectual organisation, should be the immediate aim of the Government if the men, women and children of this island are to be spared the confusion that will otherwise descend upon them in, say, 1970, when instead of our present 10,000,000 motor vehicles we shall have 20,000,000.

APPENDIX

TRAFFIC ENGINEERING, AS SEEN BY :

(1) Institute of Traffic Engineers, U.S.A. :

Traffic engineering is that phase of engineering which deals with the planning and geometric design of streets, highways and abutting lands and with traffic operation therein, as their use is related to safe, convenient and economic transportation of persons and goods.

(2) Matson, Smith and Hurd, in book *Traffic Engineering*, U.S.A. :

That branch of engineering which is devoted to the study and improvement of the traffic performance of roads and terminals. Its purpose is to achieve efficient, free and rapid flow of traffic, yet at the same time to reduce traffic accidents and casualties. Its procedures are based on scientific and engineering disciplines. Its methods include regulation and control on one hand and planning and geometric design on the other.

(3) Committee on London Roads, in Report Cmnd. 812, July, 1959 :

It applies to four aspects of road transport :

(*a*) Planning and traffic design of new roads.

(*b*) Improvement of existing roads and the improvement of traffic movement by regulation such as one-way roads, traffic lights, &c.

(*c*) Planning and traffic design of parking facilities, access to buildings, &c.

(*d*) Provision for pedestrians (including footpaths, subways, &c.).

(4) Mr. John Hay, M.P., in House of Commons, March 11, 1960 :

Traffic engineering consists of the application to road and traffic problems of common sense, based on accurate analyses of traffic movement and on a knowledge of proper highway engineering. In short, what the traffic engineer really does is, by observation and collection of data, to analyse a given traffic situation. Having done that, he makes use of that knowledge and experience to provide the remedy. Let us face the fact : a lot of that knowledge and experience consists in the use of common sense.

(5) Mr. R. J. Mellish, M.P., in House of Commons, March 11, 1960 :

I am very glad I took the trouble to do a lot of research, because I found that " traffic engineer " is something of a misnomer. I believe we might sometime think of a different title.

Creep of Steel Laboratory

A new laboratory in the E.R.A. establishment at Leatherhead, Surrey, has been built and equipped for making measurements on the creep and rupture properties of high-temperature steels used in modern thermal power stations. The main equipment consists of fifty high-sensitivity creep machines, with optical extensometers, for work on specimens from rotor forgings ; twenty-five creep machines with dial-gauge extensometers for specimens from turbine casing castings ; and seventy-five ten-specimen or three-specimen multiple-rupture testing machines. A brief description of this equipment and of the electronic temperature controllers is given here.

A RECENT visit to the new Creep of Steel Laboratory—the latest addition to the establishment of the Electrical Research Association (E.R.A.) at Leatherhead—reminded us that it is nearly forty years since the Association first became actively concerned with work on the creep and rupture properties of steels for steam turbines, boilers and pipework. It was in 1930 that the E.R.A. set up a committee, upon which steel makers, turbine makers and users were represented, to sponsor detailed investigation at the National Physical Laboratory of certain typical steels. A creep testing laboratory was built for this work at the N.P.L. and was equipped with about seventy-five high-accuracy creep testing machines. There, several steels were examined and, besides, members of the committee submitted experimental results from their own creep laboratories. It was soon evident that short-term testing was not sufficient and periods of test had to be extended to times of the order of 20,000 hours or more.

As knowledge of the properties of steels increased and steam conditions became more onerous, the number of special creep resisting alloys to be investigated increased. The test programme grew so much that the Laboratory at the N.P.L. could no longer cope with it even when the equipment had been augmented by a further fifty machines installed in 1957 at the E.R.A. laboratories at Leatherhead. Accordingly the organisations represented on the committee decided to provide for an extended programme by means of a new laboratory at Leatherhead which would be devoted principally to long-time tests. This laboratory, completed at the end of 1960, has an area of 9900 square feet and is equipped with fifty high-sensitivity creep machines fitted with optical extensometers, fifty ten-specimen rupture machines and fifty dual-purpose machines for either dial gauge creep measurements or three-specimen multi-rupture. One 15-ton creep machine is included for testing specimens from the full wall thickness of steam pipes. In addition to the creep and rupture machines, there are eleven rigs designed to test tubes stressed by internal steam pressure while at high temperature. Four such rigs have been in operation for several years at Leatherhead and will be retained.

Fig. 1—Multi-rupture machines in the E.R.A. Creep of Steel Laboratory. (Left)—Ten-specimen machines. (Right)—Three-specimen machines

The capital cost of the new laboratory has been shared by the following organisations with the addition of a capital grant from the Department of Scientific and Industrial Research: the Central Electricity Generating Board; the Water-Tube Boilermakers' Association; the British Iron and Steel Research Association; The General Electric Company, Ltd.; The English Electric Company, Ltd.; Associated Electrical Industries, Ltd.; C. A. Parsons and Co., Ltd.; Tube Investments, Ltd.; Stewarts and Lloyds, Ltd.; and Aiton and Co., Ltd.

Laboratory Building

To avoid direct solar gain and ensure uniform conditions in the new laboratory the building consists of a windowless block, with heavily insulated walls and roof. The heavy floor loading could only be sustained in a single-storey building and as that would have been out of character with the main laboratory block the new laboratory was built along the south western boundary of the site, where it would be in keeping with buildings that might be envisaged in the future.

The creep laboratory building has a clear floor span, with a light structural steel frame and lattice girders supporting a roof of aluminium decking, cork insulation and three layers of felt covered with light stone chippings to give some heat reflection externally. For additional insulation there is an "Asbestolux" ceiling lined with a layer of "Rocksil" below the roof decking. From 4ft 6in above the floor the outer walls are of ribbed aluminium sheeting which is separated by a blanket of "Rocksil" from the internal lining of "Asbestolux." Below 4ft 6in this wall sheeting gives place to 11in cavity walls.

Heat from the creep machine furnaces (up to 150kW) is dissipated by multiple air changes, and a false ceiling suspended below the bottom boom of the lattice girders serves as the lower wall of an air duct. Five strips of continuous grilles in the ceiling distribute the circulated air. Compared with the orthodox ducting system this false ceiling gives slower air movement and better internal appearance. As the building is windowless the required high standard of illumination is obtained artificially by continuous-strip fluorescent lighting fitted immediately under the ceiling and supported by a continuous service trunking, as can be seen in Fig. 1.

Creep and Rupture Test Machines

Mention has already been made of the creep and rupture test machines installed in the laboratory. The fifty high-sensitivity creep machines fitted with optical extensometers are used, generally, to measure the creep properties of specimens from steam turbine rotor forgings. Another twenty-five machines are equipped with dial gauge extensometers for measuring the creep properties of steels for the thick castings used in turbine cases.

The rupture properties of high-temperature steels used for the manufacture of pipes and superheater tubes are measured in multi-rupture testing machines. In these machines either ten specimens or three specimens, depending upon the size of the furnace, are stressed in series at the same temperature and stress, and the time to fracture of each specimen is measured. For this purpose a new multi-rupture testing machine has been developed. Ten specimens can be tested joined in series by split couplings in a furnace 50in long. The large extension obtained when a number of specimens in series creep is taken up automatically by a motorised worm and wheel. The complete chain of specimens can be assembled below the furnace and raised into position. Small "pop" marks at a precise distance apart are punched on the parallel portion of the test specimens to enable the ductility at rupture to be assessed.

Such testing machines are new to this country, and make stringent demands upon the temperature control and other equipment. Temperature control of the specimens for creep and rupture testing is achieved by electronic temperature controllers actuated by platinum resistance thermometers inserted in the furnaces, as described more fully below. The temperature of each furnace is measured by either three or five thermocouples tied to the specimens and measured at a central control desk.

From the measurements of time to reach a specific amount of creep or to rupture with variable stress or temperature, graphs are plotted which allow estimates to be made of the expected life of components used in the power station. Another major item of research in this laboratory is the correlation of the high temperature stress rupture properties obtained by uniaxial tensile tests with those obtained by subjecting thick-walled tubes to internal steam pressure. The results are then compared with predicted values obtained from three simple design formulae.

Some typical views of the laboratory are illustrated here. The multi-rupture machines in the foreground of Fig. 1 have furnaces capable of taking ten specimens and those in the background up to three specimens.

The loading beam has a ratio of 10 : 1 and a load of over 2 tons tensile can be applied to each specimen. Since each rupture specimen has a cross-sectional area of one-tenth of a square inch at its centre, the final stress that can be applied to the specimen is about 20 tons per square inch. At the beginning of each test, for major adjustments of the beam the specimens are raised and lowered by a chain and worm gear, as illustrated. On the other side of the machines, not shown in the photograph, are electric motors which are used for raising the beam as the specimens extend during tests. The motors are automatically controlled by micro-switches actuated by the loading beams.

Fig. 2 shows the control corridor for the thick-tube bursting rigs. The girl is seen adjusting a pressure control valve to one of the rigs. The assistant at the desk is measuring the temperature of one of the pressure vessels. Standard measuring gauges can be seen at the top right of the end corridor wall. They are used for calibrating the pressure measuring gauge to be seen on the control panel of each rig.

In the centre of the laboratory is an elevated room in which measurements of temperature of all the specimens in the creep and rupture machines are recorded. The one desk (Fig. 3) has three positions; the angled back portion of the desk has switches to enable furnaces and thermocouples to be selected. The illuminated display panel shows the operator which furnaces are being measured and the limits of temperature required. Inset into the desk are potentiometers which, combined with the galvanometer in the sloping back of the desk, are used for taking the actual measurements.

Control of Specimen Temperature

The main requirement of the electric furnace surrounding the test specimen is that the temperature should not deviate by more than 3 deg. Cent. from the correct value, which is about 650 deg. Cent. Because a deviation of this order could result from a change of only 0·4 per cent in the voltage applied to the furnace winding, accurate

Fig. 2—Control corridor for thick-tube bursting rigs

Fig. 3—Temperature measurement desk

compensation must be provided for the effects of fluctuations in mains voltage. Changes in ambient temperature have much smaller influence and because they are slow the appropriate correction can easily be applied automatically.

Each furnace has its own control circuit (shown diagramatically in Fig. 4) which consists of a resistance thermometer, an electronic control unit and a saturable reactor designed to compensate separately for variations in both mains voltage and ambient temperature. First, assuming a steady ambient temperature, the voltage across the furnace elements is kept constant irrespective of mains voltage variations, by the feed back loop marked (*A*, Fig. 4). Secondly, to compensate for ambient temperature changes, the output voltage from a bridge circuit (one arm of which is a resistance thermometer located close to the furnace winding) is fed to the input of the electronic control unit (*B*, Fig. 4). Because the resistance thermometer is liable to breakage when the specimens rupture, it cannot be placed in the "ideal" position inside the furnace tube. Instead it is inserted through the furnace wall, with the sensitive resistance element resting tangentially against the furnace winding. Because of doubts about the efficacy of this arrangement if the winding consisted of widely spaced turns of

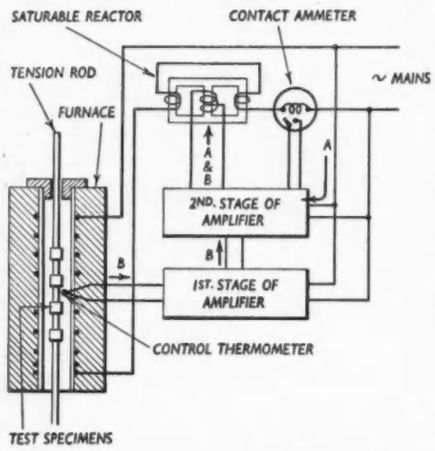


Fig. 4—Method of specimen temperature control

wire, the furnace elements were wound with closely spaced turns of ribbon. Back-up protection in the event of failure of the controller is provided by an ammeter fitted with an adjustable contact (to "make" with a fixed contact on the pointer). The ammeter is in series with the furnace winding: when the ammeter contacts touch, at the preset limiting current, the output valve in the controller receives a high negative bias which reduces the furnace current and prevents an uncontrolled rise in furnace temperature.

For the measurement of test temperatures platinum/platinum-rhodium thermocouples are attached to the specimens. Three thermocouples are fitted in the short furnaces and five in the long ones. All temperature measurements are made at a central desk in a separate measurements room. A special system of switching has been developed to reduce the number of wires and cold junctions and the amount of platinum that would otherwise be required. A selector switch near the furnace is operated remotely from the desk to connect all the thermocouples from any particular furnace, to busbars of compensating wire. A second switch on the operating desk is then operated to select the busbar appropriate to the thermocouple the output of which is then measured on a potentiometer. In this way one cold junction serves each set of busbars, and copper wires can be used for the connections between the cold junction and the measuring desk.

Power Supplies and Protection

Each furnace can be connected to any one of three busbars (90V, 100V or 110V) providing a range of voltages suitable for making tests at any temperature between 500 deg. and 750 deg. Cent. The busbars are supplied from appropriate tappings on the secondary winding of a transformer fed from the mains. Another tapping point on the transformer secondary, with a potential approximately equal to that of the middle of the furnace winding, is earthed through a current limiting resistance, an ammeter and an alarm relay. The alarm circuit draws the attention of the staff to the existence of an earth fault. The possibility of breakdown of the insulation of the furnace heating winding and the steel tube that carries it is made negligible by isolating the tube from earth and by using a low voltage (maximum 90V) across the furnace winding. The insulation can be tested in service by a voltmeter connected to the test terminal which is fitted at the base of the steel tube.

Underfloor Heating of Office Block

The office block is a simple two-storey building consisting of a structural steel frame, precast concrete floor beams, aluminium roof decking with cork insulation and three-layer felt finish. The east and west external walls are mainly of aluminium curtain-walling with double glazing throughout and stove enamelled metal panels backed with "Asbestolux" insulation for the spandril infilling. The remaining walls are in 11in cavity construction. Fibreboard false ceilings have been used throughout the building both for insulation and noise absorption. Floor finishes are generally linoleum with terrazzo, quarry tiles, wood block and cork used in particular areas.

The office building is heated by off-peak electric floor warming, partly with the object of collecting information on the behaviour of this system. It was decided to restrict heat loss as much as possible by using double-glazing; the extra cost was nearly paid for by the saving in capital cost of the heating system and it was estimated that the saving in running costs in not more than two years would meet the rest.

The direct embedded heating system was adopted. As experience with this kind of light building was not extensive the Heat Section of the E.R.A. took the responsibility of calculating the electrical loading to be installed and its distribution, while the layout and control system was designed by the floor warming manufacturer. The laying of the cables was carried out by the main electrical contractor.

Complete base and edge insulation was provided for the ground floor; it consisted of 1in thick expanded rubber ("Onazote") bonded with "Bostik." This base insulation, which was placed on top of the hardcore over a thin blinding layer of slurry, also formed the dampcourse for the building. Between the two storeys a 1in layer of mineral wool was included in the air space above the suspended ceiling.

The suspended floor is made of hollow precast concrete beams from which the ceiling is hung, an air space of 15in deep being left below the beams. The screed, which was laid several months after the beams were placed in position, is 2ft 5in thick and is covered with heavy linoleum, except in the photographic department where cork tiles are used and in the conference room which has an impregnated wood block floor and a central carpet. The screed on the ground floor is of the same thickness and was laid approximately at the same time as that on the first floor. The concrete floor panels were restricted to areas of 150 square feet in most cases and the individual floor-heating circuits were, in all cases except one, contained within these panels. The cables in all cases were parallel to the direction of lay of the floor beams.

Air thermostats containing heat barriers to minimise self-heating were used in all rooms, but the opportunity was taken to operate the whole installation by an experimental time-temperature control developed by one of the Area Boards, the thermostats being used as over-temperature safety devices. The rate of heat loss of the office block was computed using heat transmission coefficients published by the Institution of Heating and Ventilating Engineers, assuming a mean value for ventilation over twenty-four hours of one air change per hour. A mean air temperature of 65 deg. Fah., neglecting solar gain or other stray heat, was to be maintained under freezing external conditions.

The total floor area of the office block is 11,780 square feet on two floors. There are two staircases, one at each end, and a central passage on each floor. The calculated loss for 35 deg. Fah. rise was 72·32kW (including 3·45kW for the offices for the laboratory staff). The installed electrical loading was determined by multiplying this by the ratio of 24/14 (the available supply period consists of twelve hours at night and a two-hour mid-day boost), the final value being 131·54kW.

As it was feared that insufficient thermal storage in the building, apart from the floor, might give rise to high rates of cooling, provision was made in the wiring for a number of block heaters for auxiliary heating. The installation appears to be very satisfactory, however, and the block heaters were not needed during the winter of 1960–61, even in freezing weather which lasted for three days. With the loading installed it was possible to reach an air temperature of at least 70 deg. Fah. or over if required. The first estimates show that the annual consumption for the temperature rise achieved was only of the order of 70 per cent of the expected value.

One chief advantage of this method of heating is the saving of space compared with a boiler-house. All the switchgear used for the floor-heating system is contained in a corner of a small room. Some instrumentation has been included in the floor-heating system and results of great interest relating to heat flow across insulated suspended floors and rates of cooling in double-glazed curtain-walled buildings should be obtained next winter.

The architects were Messrs. Scherrer and Hicks, F.R.I.B.A., the quantity surveyor was Mr. W. J. F. Tillyard, F.R.I.C.S., and the building contractors were J. Gerrard and Sons, Ltd.

Silencing for Air Valves.—Porous Plastics, Ltd., of Dagenham Dock, Essex, has developed a range of silencers suitable for the pneumatic control valves manufactured by Martonair, Ltd., of Richmond, Surrey. These silencers, which can also be fitted to any other make of valve, are made from "Vyon," a porous plastic produced from high density polyethylene of medium pore size. The silencers fit directly into the exhaust ports of the valves and the exhausting air escapes to atmosphere through the porous plastic body. It is claimed that a silencer of ¼in B.S.P. will lower a noise level equivalent to that of a pneumatic drill to that of conversation.

MAINLY METALLURGY

by T. Henry Turner, M.I.Mech.E. M.I.Loco.E. A.R.Ae.S. F.I.M.

The British Iron and Steel Research Association

FROM the magnitude of the Iron and Steel Industry, and the undoubted fact that it has become the basis of all our present-day industrial activities, it may well be that B.I.S.R.A. is unsurpassed in importance among all the fifty or so research associations of the D.S.I.R. : on its general research programme B.I.S.R.A. spent nearly £900,000 during 1960. The seventeenth Annual Report of its Council came to hand recently and on June 15–16 the fine laboratories at Sheffield invited visitors to " Open Days."

It will be recalled that the newly-built Sheffield group of laboratories was opened by H.R.H. The Duke of Edinburgh in 1953, and that " Open Days " were last held at these Sheffield laboratories of B.I.S.R.A. in 1956. They are not the only laboratories at which this association conducts research ; other important sections are to be found in Battersea, Normanby, and Swansea. In addition, the Association has enlisted the help of many people, in the laboratories of member firms, and also in universities and other D.S.I.R. research associations who were engaged wholly or partly in work for or in conjunction with B.I.S.R.A. and who may be termed extra-mural research officers.

The scope of all this work can be gathered by noting the main organisation that has grown up to include five " Divisions," Ironmaking, Steelmaking, Mechanical Working, Plant Engineering and Energy, and finally Metallurgy (General). There are also three " Departments," Chemistry, Physics, and Operational Research, as well as Development and Information Services.

During the past five years there have been many developments at the Hoyle Street laboratories, in Sheffield, and in addition to displays in the Steelmaking, Mechanical Working, and Metallurgy Divisions, visitors and friends were given an opportunity of seeing a demonstration of the Abstract and Book Title Index Card Service (ABTICS) by the Deputy Secretary, Mr. A. Post, and Mr. Saville, the Information Officer of the Iron and Steel Institute. Since this novel system was introduced last year (see THE ENGINEER, April 1, 1960, page 565, " Metals, Abstracts and Books") it has attracted world-wide attention and now gives service to many countries.

At the " Open Days " the display of work was arranged in two parts, the general picture being obtained by following a conveniently arrowed " Ingot Route." For those with specialist interests detailed auxiliary exhibits were set out, and as the visitors had been provided with a 3½in by 7¾in card bearing their name at the top, to carry in their breast-pocket, and as the B.I.S.R.A. staff showed similar cards, note taking and introductions were much aided. This courtesy deserves imitation at many such functions. The Conference Room was thoughtfully arranged as a " rest point," where a display was mounted that had been produced for the " Automation in the Steel Industry " conference, organised by B.I.S.R.A. last October.

Engineers will be interested to know that the fitments holding descriptive literature on many of the displays were made from plastic-coated steel produced by B.I.S.R.A.'s " Plasteel " process. For the use of research workers in member firms and academic laboratories, B.I.S.R.A. maintains at these Hoyle Street laboratories a " bank " of " pedigree " irons and steels. These are catalogued by the library and inquiries for them should be made through the staff of the Metallurgy Division.

B.I.S.R.A. occupied some of a group of old buildings and small factories on this Hoyle Street site as early as 1949, and when the new laboratories were being built during the years 1950–53 care was taken to preserve, as an important industrial "historical monument" in one of the courtyards, the last of the old cementation furnaces that was still in operation in the late nineteen-forties. For decades before the converter and open-hearth furnace were introduced these old cementation furnaces were used in steelmaking.

Steelmaking Division.—The steelmaking division aims to develop and improve plant and processes so that maximum efficiency may be achieved and maintained. This division includes three sections : Steel Practice, Furnaces, and thirdly, Ingots and Continuous Casting. For work on experimental plant and pilot-scale constructions it has a large melting shop.

Mechanical Working.—The field of work of the mechanical working division covers sheet and strip production, rolling, forging, extrusion and wire production. A variety of heavy equipment is housed in the large mechanical working shop used by the division; its experimental forge and 14in rolling mill are especially notable. In one of its smaller laboratories a scale model of a five stand mill has been installed to help in the study of the many problems that are involved in continuous rolling operations. Visitors were also shown the results of recent research on programmed forging, wire drawing, and extrusion practices. This division also has laboratories at Swansea, where a new method of rapid annealing has been developed.

Metallurgy Division.—Physical, chemical, and mechanical properties of iron and steel are the concern of the Metallurgy Division, which studies the effects of variations in the manufacturing processes upon these properties.

This division provides metallurgical services to other sections of B.I.S.R.A., industry, other research organisations, and universities ; its main research programme being divided between physical properties, mechanical properties, metal treatment and metallurgical analysis, which no includes optical and X-ray methods, spectrography, electron-beam microanalysis and other such most helpful developments. Their display of continuous vacuum degassing will inspire much thought.

Technical Services.—For many makers and users of iron and steel the technical services of B.I.S.R.A. are invaluable and any engineer who has not already made use of them should take especial note of :

(1) Development and Steel User Section ;
(2) Corrosion Advice Bureau ;
(3) Samples for Research ;
(4) Operational Research Advisory Bureau ;
(5) Computer Applications ;
(6) Consultative Services ;

as sections of B.I.S.R.A. that may well be of great help to him. The chart of Committee Organisation at the end of 1960 shows that B.I.S.R.A. has no less than eighty committees and sub-committees, and the useful and most impressive list of their members covers pages 129–146 of the annual report.

Anodised Aluminium: Conference in Nottingham University

In order to provide an opportunity for anodisers, users of anodised aluminium, and industry to discuss technical developments, and for research workers to discuss fundamental aspects of this subject, the Aluminium Development Association and the Department of Metallurgy, Nottingham University, are organising a short residential conference in the grounds of that university. Technical sessions will start on the afternoon of Tuesday, September 12, 1961, and continue on the following morning and afternoon, the conference ending officially after breakfast on Thursday.

Sessions	Subjects	Authors
I	" Anodising from the User's Viewpoint "	1. J. M. Perfect 2. J. G. Simmons 3. Professor J. W. Cuthbertson and J. C. Bailey
II ...	" Special Surface Characteristics "	4. Dr. B. A. Scott and H. M. Bigford 5. —
III ...	" Current Views on Anodic Coatings "	6. Dr. J. F. Murphy and C. E. Michelson 7. R. W. Franklin 7. R. W. Franklin 8. Professor H. Ginsberg and Dipl. Phys. W. Kaden
IV ...	" Industrial Applications "	9. T. E. V. Stephenson 10. J. J. Lee 11. W. J. Campbell
V ...	" Theory of Related Processes "	12. A. W. Brace 13. Dr. C. H. Giles
VI ...	" Advances in Anodising Techniques "	14. V. F. Henley 15. Captain J. Fox-Williams and H. L. Watts

" Cripps Hall," one of the University's new buildings, will provide the necessary accommodation and the all-in charge for the Conference is five guineas. For two nights only, this is reduced to four guineas, and for meals only, three guineas for each person. Forms of application, containing full details of fees, times, and so on may be obtained from The Secretary, The Aluminium Development Association, 33, Grosvenor Street, London, W.1.

LETTERS AND LITERATURE

Letters to the Editor

BI-CENTENARY OF JOHN RENNIE

SIR,—I have read with great interest your special article on the bi-centenary of the birth of John Rennie in your issue of June 2, 1961, as Jessop and Co., Ltd., Calcutta, has an historical connection with this famous engineer.

In 1815, the year of Waterloo, Henry Jessop, one of the founders of the company which bears his name, on behalf of the Nawab of Oudh, brought out from England the "Lohar ka Pulh," or "Iron Bridge," made by the Butterley Iron Works at Derby, which to this day still spans the River Gumpti at Lucknow, in the State of Uttar Pradesh in India. The bridge, a handsome structure in three spans, is sufficient proof of the artistic sense of the famous Rennie, the designer of this the oldest bridge in India, while his skill as an engineer is testified by the heavy road traffic, far in excess of anything he could possibly have visualised, now being used on the bridge.

Human interest is stimulated when we read from historical records in connection with this bridge that Henry Jessop left Calcutta for Lucknow in January, 1816, accompanied by two English artificers named William Burton and William Trickett. Yet another interesting document dated Lucknow, August, 1816, reports that less than 100 of the total 2425 components of the bridge—mostly cast iron and many of large dimensions—were cracked or broken on arrival at Lucknow, a very creditable performance considering the limited transport facilities then available.

C. E. CARGIN,
Member, Board of Management,
Jessop & Co. Ltd.

Calcutta,
July 15, 1961.

GALVANISED STRIP FOR AUTOMOBILES

SIR,—I read with interest in the July 21 edition of THE ENGINEER the article on galvanised strip for automobiles by Mr. K. P. Scott and Mr. M. H. Davies. It would appear that one of the difficulties encountered in the use of galvanised strips for certain underbody sections of motor-cars is the rather more difficult technique required in the welding operation. Furthermore, those areas which have been welded will not be protected by the zinc coating and will thus be trouble spots as far as subsequent rusting is concerned. This can be overcome by zinc spraying the welded structure after fabrication. The zinc sprayed coating will not only provide a most satisfactory film for the protection of corrosion, but will also provide an excellent key for any subsequent paint operation which may be applied.

Furthermore, there are certain parts of cars which are subject to heavy corrosion due to a combination of heat and moisture. These parts are for instance the exhaust manifold, down pipe, silencer and tail pipe. Already several motor manufacturers are having these parts aluminium sprayed very successfully and no doubt this practice will develop further. Those areas which could be most effectively zinc sprayed after fabrication are wheels, sub chassis components, and other underbody assemblies.

R. K. FLETCHER

Arkley,
Herts.
July 31, 1961.

MOTOR VEHICLE NOISE

SIR,—In making an experimental correlation between heard and measured intensity of noise from motor vehicles Messrs. C. H. G. Mills and D. W. Robinson have helped to advance this difficult subject. They have also attempted a further deduction on the basis of the reports from observers who took part in these experiments they state that a level close to 80dB is not objectionable in the opinion of typical British listeners. Out of fifty-seven observers twenty-eight were from the Motor Industry Research Association's staff. Thus half the observers depended directly on the motor industry for their livelihood. This could not be described as a typical or even an unbiased group. If an equal number of professional listeners, say piano tuners, had acted as observers, the figures might have been very different, though probably biased in the other direction.

We may value the correlation which they have established but should reject the suggested high level of 80dB as not proved, and await some better balanced experiment.

S. K. BAB

Datchet, Bucks.
July 14, 1961.

Book Reviews

The Stability of Motion. By N. G. CHETAYEV. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 60s.

THE material of this book is a re-presentation of a selection of material from a memoir by A. M. Lyapunov, *General Problem of the Stability of Motion*, published in 1892 by the Mathematical Society of Khar'kov. The original memoir is only available in French (apart, perhaps, from its author's language). It was translated in 1907 for the *Annales de la Faculté des Sciences de Toulouse* (corrected and approved by the author), and this translation has been used in the Princeton University Press series *Annals of Mathematics Studies*. It appeared in this series in 1947 as No. 17. Here, and in most English references, the author's name appears in the older style of spelling, Liapounoff.

Lyapunov's investigation is a study in the field of classical mechanics as defined and developed by Lagrange, and the Lagrangian canonical form of the equations of motion of a dynamical system is taken as defining the problem. It is therefore strictly "pure" applied mathematics, using this term to contrast with engineering applied mathematics. Lyapunov is in the direct line of succession from Lagrange, D'Alembert, Sylvester, Rayleigh, Poincaré, Routh, Kelvin, on all of whose work he draws; and it is apparent that some of the stimulus for his own work came from Routh's contemporary investigations, particularly the Adam's Prize Essay on Stability in 1877. Judging from the French edition the standard of presentation is quite in accord with the elegant and lucid mathematical writing which has been a feature of treatises on classical mechanics in France and England.

The new book by Chetayev maintains this high standard of presentation. What is not apparent is the particular contribution of the later author. Apart from the examples he uses to illustrate general theorems the material appears to be taken exclusively from Lyapunov's memoir with no very important differences. In his own foreword, Chetayev declares his purpose as . . . "I have tried to present Lyapunov's results in a simple manner, without false modernizations." Setting aside the ominous sounding but obscure last phrase, there does not appear to be a noticeable difference in simplicity of presentation (nor is it really needed) over that in the original memoir. There is no doubt that an English version of this extensive investigation of stability is very desirable, and while we are grateful to the publishers for producing a book from which they cannot hope to gain a great deal financially it is regrettable that Lyapunov's original paper was not chosen for translation.

The main problem discussed in the book is the following. A dynamical system is defined by its Lagrangian co-ordinates and it is assumed that a solution of the equations of motion exists, though it need not be explicitly known. The motion corresponding to this solution is called the unperturbed motion. If now arbitrary small increments are given to the co-ordinates and momenta at time $t=t_0$, the behaviour of the system for $t>t_0$ is required, in particular the extent to which the perturbed motion differs from the unperturbed motion. When the difference between the co-ordinates in the perturbed and unperturbed motions has a small enough upper bound, the unperturbed motion is defined as stable. The magnitude relations between the incremental changes at $t=t_0$ and the subsequent perturbations is of course involved, and the definition of stability has its meaning in this context. The author deduces one basic theorem and then extensively discusses its implications and applications. This basic theorem, which he calls Lyapunov's Stability Theorem after its originator, depends on the deduction and examination of a test function V. From the point of view of applying the theorem and the method to make decisions about any given situation, the real problem would be the deduction of V. Given V the procedure is definite, but the analysis does not give a method of choosing V in any arbitrary problem.

A fairly extensive treatment of simultaneous linear differential equations is included with the object of examining the signs of the roots of the stability polynomial. This is initially familiar ground, but it is developed later in a specialised manner to suit the Lyapunov Stability Theorem. Separate chapters are given for the critical cases

of a zero root and of a pair of purely imaginary roots of the stability polynomial. There is a chapter on the much more difficult topic of transient motion—using Routh's definition of transient motion as the case when the right-hand sides of the Lagrangian equations of disturbed motion are time dependent.

Probably the best English text to be used in conjunction with all these topics is E. T. Whittaker's book *Analytical Dynamics*, most strikingly omitted by Chetayev in his references, though of course it is later than Lyapunov's work.

The publishers explain that the high price of the book is a matter of necessity, considering the translation costs and the very restricted market. The reproduction by photolithography results in occasional smudged or faint letters but is not a serious handicap even in the case of complicated formulae. The English version is fluent and easy to read although it has that inevitable flavour of a translation. There is a slight slip on page 38 where a theorem is said to prove that "the real root x is real"! This is a book for the specialist, and as an addition to the specialist literature in analytical dynamics it is valuable.

Gases at High Densities and Temperatures. By YU. N. RYABININ. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 25s.

THIS small volume is a translation by H. K. Zienkiewicz originally published in Moscow by Fizmatgiz in 1959. The author describes an interesting technique for the study of the behaviour of gases at pressures and temperatures up to 10,000 atm and 9000 deg. K and the results of his experiments.

As an introduction the results obtained by other workers in this field are briefly reviewed. The author then goes on to describe the apparatus that he has developed. In principle the method used is simple; the gas under investigation is compressed adiabatically in a cylinder by a heavy and accurately fitted piston which is "fired" along the cylinder by means of a compressed driving gas. The inertia of the piston serves to compress the test sample to a far higher pressure than the driving gas. When the energy in the piston has been expended it is allowed to return along the cylinder, the driving gas being automatically vented to the atmosphere. Due to the very short time taken by compression, of the order of 0·01 seconds, the process is almost adiabatic and the cylinder is kept cool.

Details are given of the equipment used to estimate the pressures achieved and to study properties of the sample, including the electrical conductivity and the light emission. The many practical difficulties involved and the methods by which they were surmounted are also discussed. The gases studied in these initial experiments were commercial argon, air, nitrogen, carbon dioxide and methane. All these gases were compressed to about 10,000 atm, but the peak temperatures were naturally only obtained with the monatomic argon. Out of the considerable amount of data that the author was able to obtain from his experiments, perhaps the most interesting is the conclusion that argon behaves almost as a perfect gas at the very high temperatures and pressures achieved.

This booklet should prove to be of interest to those concerned with gases at high temperatures and pressures and of particular value to those engaged in research. For the work reported in this book the author was awarded the D.I. Mendeleyvez Prize by the U.S.S.R. Academy of Sciences.

Basic Principles of Fission Reactors. By W. R. HARPER. Interscience Publishers Inc. New York; Interscience Publishers, Ltd., 88-90, Chancery Lane, London, W.C.2. Price 57s.

IT is ten years since electricity was first produced from nuclear fission, and fission bibliography is understandably very much in its infancy. While Dr. Harper's book is not a landmark in this field, it clearly makes an interesting, healthy and well-informed contribution. The purpose of the book, to take the reader to "about the stage at which detailed reactor design begins," is sensibly modest and adequately fulfilled.

As Dr. Harper asserts, present technology cannot be understood without reference to existing reactors, and the descriptions of these, Calder, Windscale and the early Harwell reactors in this country, are intelligently presented. The account of the early American scene, including the famous West Stands experiment and the Hanford reactors (with no mention of their output of course) is particularly good as information is not readily available elsewhere. Inevitably, at this early stage of the technology, refinements of empirically determined parameters make recourse to numerical exposition risky. Some minor adjustments are necessary in the figures for delayed neutron yield, which is not now so optimistic, and for the percentage heat liberated in the fuel. This adjustment is also required for certain statements of principle now that it is known that Wigner growth can be Wigner shrinkage, and that the moderator temperature coefficient goes positive after a period of irradiation. There are also two design points: first, that graphite sleeves are going out of fashion, and second, that the word "diagrid" has not become generally adopted despite what textbooks and journalists repeatedly assert. All these are, however, minor errors in a book which is remarkably free of them, and it is also refreshing to find an author of "basic principles" who refuses to pronounce at a distance on the economic potential of reactors.

The Hall Effect and Related Phenomena. By E. H. PUTLEY, B.Sc., Ph.D., A.Inst.P. Butterworth and Co. (Publishers), Ltd., 4 and 5, Bell Yard, London, W.C.2. Price 50s.

THE purpose of this book is to describe recent developments in the study of electronic conduction in semiconductors, beginning with the conceptions which followed the observations by E. H. Hall in 1879 when investigating the nature of the force acting on a conductor carrying a current in a magnetic field. The first chapter reviews the development of the study of semiconductors from the first electron theories to the work of recent years, and describes the part which the study of conduction processes has had in this development. In the following chapters the conduction properties and experimental techniques for measuring them are described, the formal theory of conduction is considered, and the interpretation of experimental results to obtain more fundamental information is discussed. The properties of the more important semiconductors are summarised in the last chapter. Throughout the book emphasis is placed on the evaluation of experimental data with a special eye to the needs and interests of those concerned with semiconductor research and development. Much of the information will also be of value to readers engaged in other branches of solid state physics, and to honours students.

Technical Reports

The Aerodynamic Drag of Near Earth Satellites. By G. E. Cook. A.R.C. Current Paper No. 523. H.M. Stationery Office. Price 6s. 6d.—To determine the density of the upper atmosphere from the orbital motion of a near earth satellite a knowledge of the satellite's drag is required. In this note, the drag of a body in free molecule flow, the flow régime appropriate to a satellite in orbit, is discussed, and the molecular speed ratio is related to the properties of the upper atmosphere. The mechanism of molecular reflection at the satellite's surface and the surface temperature are considered. The drag coefficients of some simple shapes are quoted for molecular speed ratios, and the drag coefficients are obtained for cylinders and a cone with axes inclined at any angle to the direction of motion.

Since this paper was written, early in 1959, several papers dealing with molecular reflection at the surface of a solid have appeared. None of them add anything, however, to the knowledge of accommodation coefficients except for the suggestion that the values obtained by Wiedmann may be inaccurate due to experimental errors.

Sound Absorbing Materials. By E. J. Evans, B.Sc., and E. N. Bazley, B.Sc. D.S.I.R., by H.M. Stationery Office. Price 3s.—Sound absorbing materials are being used increasingly for the control of the acoustical properties of concert halls and noise reduction in offices, &c., and measurements of the sound absorption coefficients of suitable materials have been carried out for a number of years at the National Physical Laboratory. These measurements have been made on most of the proprietary materials used in this country as well as forms of special treatment and mounting. In the new booklet the results of these investigations have been brought together and made available for the benefit of users, manufacturers, architects and others concerned with the application and properties of sound absorbents.

The main section of the booklet consists of tables of the absorption coefficients of over 300 materials measured at the laboratory, and in the booklet both the materials and the method of mounting employed are described. The materials are classified broadly according to their physical characteristics, those of the same acoustical type being grouped together. The tables are accompanied by a discussion of the results, whilst the authors also describe recent developments in the design of sound-absorbent materials as well as the various types of materials and the physical processes involved.

A Direct Method of Calibrating Sealed-Chamber Air-Content Instruments. By A. T. J. Hayward, B.Sc. (Eng.). National Engineering Laboratory Fluids Note No. 96. No price quoted.—A method is described of calibrating experimentally any instrument of the sealed-chamber type for determining the air-content of oils. The calibration is simple to perform, requires very little apparatus, and takes only about five minutes. If several successive calibration tests are performed the accuracy of the mean value of the calibration constant should be within 1 per cent. The procedure is to release air at a known pressure from a known volume within the instrument into the unknown volume and measure the pressures before and after.

Books Received

Surface Structures in Building. By Fred Angerer. Alec Tiranti, Ltd., 72, Charlotte Street, London, W.1. Price 18s.

Measuring for Engineering and Other Surveys. By Michael V. Smirnoff. Prentice-Hall, Inc., 28, Welbeck Street, London, W.1. Price 84s.

Transform Calculus for Electrical Engineers. By Roger Legros and A. V. J. Martin. Prentice-Hall, Inc., 28, Welbeck Street, London, W.1. Price 50s.

Analytic Geometry and Calculus. By L. J. Adams and P. A. White. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 78s.

Mechanical Drawing Essentials. Third Edition. By F. T. McCabe, C. W. Keith and W. E. Farnham. Prentice-Hall International, Inc., 28, Welbeck Street, London, W.1. Price 35s.

The History of the Calculus and its Conceptual Development. (The Concepts of the Calculus). By Carl B. Boyer. Dover Publications, Inc., 180, Varick Street, New York 14, N.Y. Price 2.00 dollars.

Oil in the Middle East, Its Discovery and Development. Second Edition. By Stephen Hemsley Longrigg. Published for the Royal Institute of International Affairs, by Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 35s.

Welding Handbook. Section Four: *Metals and Their Weldability.* Fourth Edition. Edited by Arthur L. Phillips. Published by American Welding Society, obtainable from Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 72s.

Doncaster By-pass Motorway

THE illustrations and text on page 199 herewith give a good idea of the Doncaster by-pass, now open to traffic, which has proved to be a difficult engineering task to complete. Some further information is given here, first of all on some of the outstanding points in design and construction of the 12½ miles of motorway in the West Riding.

One of the major constructional difficulties in this section was the large amount of rock which had to be excavated. It was found that only the biggest types of mechanical shovel (110 RB and 54 RB) could successfully deal with the material and most of it had to be blasted in any case. Another major difficulty was the presence of about ¾ mile of peat bog averaging about 6ft thick which had to be entirely removed and replaced by granular material.

Mining subsidence, which is likely to take place to a greater or lesser degree in the relatively near future—up to 14ft has been forecast—has been a major design consideration both for the road and bridgeworks, which has resulted in a construction as flexible as possible. This has been reflected, *inter alia*, in the following design features :

(1) The type of carriageway construction consisting of granular sub-base, cement-bound granular base and hot rolled asphalt surfacing.

(2) The provision of deeper inverts for certain culverts to allow for stream regrading in the event of mining subsidence.

(3) The adoption of simply supported spans for bridges carried on synthetic rubber bearings.

(4) The choice of expansion joints.

(5) The provision of jacking facilities for all bridge decks.

(6) The adoption of flexible piers and reinforced concrete abutments capable of withstanding mining subsidence stresses.

Among some of the special constructional features incorporated in the motorway in the West Riding are the following. There are steep (1½ vertical to 1 horizontal) rock slopes in the Warmsworth cutting, and the rock outcrops at the northern end of the motorway. Precast concrete drains were adopted in rock cuttings where french drains turned out to be impracticable. These at once form an efficient drain, a firm backing to the hard shoulder, and a visual definition.

The hard shoulder construction is virtually the same as the carriageway construction; it includes surface dressing with white chippings to give a clear definition.

A rock-faced surface texture treatment has been given to several bridge abutments, produced by lining the formwork with preformed plastics linings. This method gives the advantages of monolithic construction and produces an interesting surface finish. The treatment has also been used in a varied form for retaining walls. Two bridges have been given fascia treatment of strong colour as a full scale experiment.

All bridges have open steel parapets and have been painted in varying colours to avoid monotony. A feature is that all top horizontal parapet rails are painted white. In spite of the limitations in bridge design imposed by mining subsidence, every effort has been made to produce an attractive and graceful appearance.

Care has been taken in the general design to blend the motorway into its surroundings, particular attention having been paid to embankment approaches to overbridges, and the overbridges themselves, in order to avoid them being starkly conspicuous. Small areas of land alongside the motorway are available for landscaping treatment, and when the whole of the planting has come to maturity in a few years it is expected that the motorway will have been completely blended into the countryside. The principal constructional quantities for the West Riding section of the road are given in the table.

Principal Construction Quantities for the West Riding Section of the Doncaster By-pass

Total excavation	3,000,000 cubic yards
Rock	2,700,000 tons
Soft	1,500,000 tons
Dry-lean concrete	100,000 cubic yards
Shale sub-base	500,000 tons
Hot rolled asphalt	65,000 tons
Concrete marginal haunch	48 miles
Drains and culverts	60,000 linear yards
High tensile prestressing wire	700 miles
Prestressed concrete bridge beams	32,000ft run
In situ concrete to bridges	29,000 cubic yards
Mild steel reinforcement	2100 tons
Structural steel	2744 tons
Fencing	48 miles

In Nottinghamshire, the A1 is now routed westwards from Markham Moor over the recently completed East Retford by-pass via Checkerhouse and over the previous A614 trunk road to the Blyth by-pass and Doncaster motorway. The section of the Doncaster motorway in Nottinghamshire, 2¾ miles in length, together with the Blyth by-pass, was undertaken as a separate contract and the Blyth by-pass was in fact opened to traffic in December, 1960.

The motorway traverses part of the Nottinghamshire coalfield, and as in the West Riding, a flexible type of construction has been adopted; 24ft wide carriageways surfaced in hot rolled asphalt are divided by a central grassed reservation 15ft wide, and 10ft wide hard shoulders surfaced in dense tarmacadam flank each carriageway. The road base is constructed in cement bound granular material, local gravel and site sand being used for this purpose. A special batching plant was erected on the site to process this material.

Access to the motorway is by a 240ft diameter roundabout at the junction with the Blyth by-pass just north of Blyth. In view of possible future settlement at the bridges, jacking beams have been provided to allow for raising of the bridge decks should this be necessary, and the bridges constructed in two halves to allow for any differential settlement. The motorway also crosses the unclassified road to Styrrup where it is in a cutting approximately 60ft deep ; it was decided to dispense with a bridge by diverting the unclassified road at this point. The motorway has been designed to blend in with the surrounding countryside and additional land has been acquired for tree planting.

Organisations and Firms

The overall responsibility for the motorway, as with all the national motorway routes, has been carried by the Ministry of Transport and the Ministry's engineering staff. However, design and supervision of construction was in the hands of the county surveyors. The 12½ miles of motorway in Yorkshire were designed by Colonel S. Maynard Lovell, O.B.E., county surveyor and surveyor of West Riding County Council ; the main contractor for this section was the consortium Cubitts-Fitzpatrick-Shand. The southern 2½ miles, plus the Blyth by-pass, were designed by Mr. R. A. Kidd, the county surveyor of Nottinghamshire County Council, and here the main contractor was Sir Robert McAlpine and Son, Ltd. One railway bridge was designed for the British Transport Commission by Mr. John Dossor, and the remainder jointly by the Chief Engineer, British Railways, Mr. A. K. Terriss, and Messrs. Rendel, Palmer and Tritton. Earlier notes on the road were published in THE ENGINEER on January 1960, 15, page 85, and May 1, 1959.

Road bridge on the Nottinghamshire section of the by-pass

Last Monday, the Doncaster by-pass motorway was opened by Mr. Marples, the Minister of Transport. This £6,000,000 scheme comprises the by-pass proper, which is built to motorway standards throughout with dual two-lane carriageways, extending for 15 miles through Nottinghamshire and the West Riding, and at its southern-end, 1½ miles of dual carriageway all-purpose road forming the Blyth by-pass. On this page we illustrate the 12½ mile section of the motorway in the West Riding. ABOVE RIGHT is the major structure of the scheme, the Don bridge, which is a seven-span viaduct 760ft long, crossing the Don valley at a height of 70ft above the river, and comprising two separate structures, one for each carriageway. The concrete columns are carried on bored cylinder piles 4ft. 6in in diameter. Five riveted steel girders support each carriageway, there being a 9in reinforced concrete slab built on these girders and structurally continuous with them. The viaduct has one 180ft span, four 100ft spans and two 90ft spans, the three central spans comprising a suspended span of 100ft, two 40ft cantilevers and two 100ft anchor spans.

Prestressed concrete has been extensively used in the other bridges. A typical overbridge, which gives a good idea of the appearance and general design of the bridges in the Yorkshire section, is shown BELOW. The illustration CENTRE shows a footbridge in the foreground, an overbridge and characteristic lane markings.

There are more than thirty bridges in the complete scheme, which includes two two-level interchanges and terminal roundabouts. A two-level interchange with the future extension of M1 is envisaged. The new road completes a 27 mile westward diversion of the A1, and is the largest of a big series of improvement schemes strung along the A1; Mr. Marples remarked that :—"There are now 119 miles of dual carriageway open to traffic on the Great North Road. A further 42 miles are being built. Work has been authorised and will start soon on a further 10½ miles. Preparations are being made for the dualling of 75 miles more. So we shall soon be well past the half-way mark on this first of our five great projects in the road programme."

150-Ton Diesel Railway Breakdown Crane

A DIESEL-ENGINED railway breakdown crane of 250 tons capacity, designed and built by Cowans Sheldon and Co., Ltd., Carlisle, for the Quebec-Cartier Mining Company of Canada, was described in our issue of November 4, 1960, and in that article it was mentioned that a second crane of 150 tons capacity had also been ordered. This second crane of generally similar construction was recently completed and underwent its acceptance trials at the works of Cowans Sheldon and Co. Ltd. It can be seen in the accompanying illustration. (The capacities quoted are in short tons of 2000 lb).

The crane is mounted on a six-axle, double bogie carriage for 4ft 8½in gauge track and its capacities are given in the table below. In running order, with the jib suspended and blocks supported on a match truck, the maximum axle load is 50,000 lb. With outriggers set the maximum lifting capacity at 17ft 6in radius on the main hook is 300,000 lb and on the auxiliary hook 112,000 lb. at 21ft radius, the hoisting speeds at these maximum loads being 6½ft per minute and 20ft per minute respectively. Lighter loads may be lifted on each hoist at automatically increased speeds up to twice the full-load speed with half the full load being lifted. A maximum load can be slewed through a full circle in two minutes and the jib derricked in from running height to minimum radius in approximately two minutes. Rated loads are derricked from maximum to minimum radius at 15ft per minute, whilst the crane will travel with a load of 56,000 lb upon the hook up a straight 2½ per cent grade, at 130ft per minute, or, on the level, at 260ft per minute.

Capacities of Crane Standing Level

Crane fully jacked			
Main block		Auxiliary block	
Radius	S.W.L., lb.	Radius	S.W.L., lb.
17ft 6in	300,000	21ft 0in	112,000
20ft 0in	260,000	23ft 9in	112,000
25ft 0in	175,000	29ft 3in	112,000
30ft 0in	118,000	34ft 10in	93,000
35ft 0in	84,000	40ft 3in	67,000
40ft 0in	56,000	45ft 6in	46,000
Crane jacked on end beams only			
17ft 6in	180,000	21ft 0in	112,000
20ft 0in	145,000	23ft 9in	110,000
25ft 0in	100,000	29ft 3in	78,000
30ft 0in	73,000	34ft 10in	58,000
35ft 0in	55,000	40ft 3in	44,000
40ft 0in	42,000	45ft 6in	34,000
Crane free-on-rails			
17ft 6in	56,000	21ft 0in	44,000
—	—	23ft 9in	35,000
—	—	29ft 3in	24,000
—	—	34ft 10in	17,500
—	—	40ft 3in	12,500
—	—	45ft 6in	8,500

A Rolls-Royce six-cylinder diesel engine rated at 179 b.h.p. at 1800 r.p.m. powers the crane, and drive is transmitted through a Twin Disc torque converter mounted on the engine flywheel housing. This equipment is designed to start satisfactorily with an engine temperature of minus 10 deg. Fah. and with the 32V electric starting set are provided a Start Pilot carburettor (ether) and a self-contained hydraulic emergency starting equipment. A hydraulically driven fan is provided for the radiator, the air intake louvres for which are operated by a thermostatically controlled hydraulic mechanism. The coolant system incorporates an immersion heater to which current is supplied from the power mains system when the crane is in its depot. An immersion heater is also fitted on the 150 gallon fuel tank. A Lister air-cooled diesel engine developing 8½ b.h.p. at 1800 r.p.m. is close-coupled to a 4kW alternator supplying current for the crane lighting system.

Drive from the hydraulic torque converter is transmitted to the crane machinery through an epicyclic reverse gearbox, spiral bevel gears and cardan shafts. The ramshorn main hook is carried on eight falls and the trapezoidal auxiliary hook on four falls of steel wire rope, the ropes being coiled upon cast-steel barrels. The motion transmission gearing is arranged in conjunction with the torque converter to provide automatically increased speeds with reduced loads and a separate multi-jaw clutch and brake serves each hoist. Drive to the slewing-rack is transmitted through reversible friction clutches and bevel and spur gearing. A multiple purchase of wire rope supports the swan neck jib and the rope barrel is driven through reduction gearing, the drive being self-sustaining with a brake interlocked with the clutch.

A frame of welded steel plate carries all the machinery, the engine and counterweight, and the whole of the superstructure is enclosed in a sheet-steel insulated cab. All windows in the superstructure are of toughened glass set in rubber glazing-strip, and, except for the front window of the driver's cab, are double glazed.

150-ton diesel driven breakdown crane undergoing tests at maker's works

Roof sections over the main machinery are hinged to lift with the derricking tie rods. The superstructure rotates on a large-diameter roller thrust-bearing consisting of a live ring of conical steel rollers rotating between upper and lower pathways. A centre-pin is secured in the carriage to maintain the superstructure in correct alignment and to carry the upward forces.

The driver's compartment is partitioned off at the front right-hand side of the superstructure and in it the controls are grouped for convenient operation. In these controls the reverse gear and clutches are pneumatically operated, the throttle and brakes being controlled manually. Safety in operation is ensured by the fitting of a clearly visible radius indicator on the jib and the use of electronic weighing equipment for the main hoist.

A carriage frame of welded high-tensile steel construction has a machined seating for the superstructure roller path in the main top plate, and housings for the telescopic drawbeams and the coupler pockets form an integral part of the structure. In the six-wheel bogies of "Commonwealth" cast steel design the axle loads are equalised, and jacking screws embodied in each spring group relieve the springs of excess loads when the crane is working.

Drive for crane travelling purposes is taken by a shaft passing through a bore in the superstructure centre pin and is transmitted to the inner axle on each bogie through reduction gearing. Sliding pinions are used to disconnect the drive when the crane is being hauled in a train. Westinghouse air brake equipment is fitted to provide automatic braking when the crane is hauled in a train, and clasp brakes operate on all wheels through compensated rigging, an air cylinder being provided for each bogie. The crane driver's brake valve controls independent straight air braking and hand-operated brakes operate through the same rigging.

The crane has two 100W floodlights at the jib head, two 250W floodlights on the front of the superstructure for operational use, and conventional tail lamps, cab lights and hand inspection lamps. Power for these lights is supplied from the auxiliary generator, and, in addition, 2kW points in receptacles on the carriage-side provide power for external use. A comprehensive range of tackle provided for crane service includes a lifting-beam, single and two-leg wire rope slings of various lengths and capacities, and a selection of shackles.

PITTING OF DIESEL CYLINDER LINERS.—The paper presented to the Diesel Engineers and Users' Association by Mr. H. H. Collins of The British Cast Iron Research Association, and entitled "Pitting of Diesel Cylinder Liners" has been published together with the discussion in the transactions of the Diesel Engineers and Users' Association, 18, London Street, London, E.C.3, from whom copies are obtainable, price 15s.

SHORTER REPORTS

Central London Heliport

THE report has now been published of the Committee on the Planning of Helicopter Stations in the London Area. (H.M. Stationery Office, price 7s.). The Committee was formed to consider the factors affecting and the possible choice of sites for heliports on two assumptions, either that fares become low enough to result in international and internal flights originating in city centres, or that helicopters are used by small numbers of travellers to whom time is worth much money. In fact the Committee made a study of traffic prospects and decided that the most probable level of traffic was so much nearer the first than the second alternative that the second did not merit attention ; it anticipates that scheduled services will involve movements in central London of 40,000 passengers in 1965 and 1,500,000 in 1979. However, a large number of charter flights, mainly by single-engined machines, are also envisaged, so that a site near the River Thames is mandatory. Nine sites were considered, two of them at Nine Elms, and three were picked out as potentially valuable, one on a platform over the goods depot at Nine Elms, one on and beside the roof of Cannon Street Station, and one on a platform 50ft high at St. Katharine docks. The first and third sites lie in public ownership, but the Port of London Authority object to this use of St. Katharine docks as incompatible with their other functions. These sites are suggested for use in locating the first London heliport, it being deemed too early to consider the planning of subsequent heliports.

To a significant extent the choice of sites is circumscribed by the need to avoid subjecting neighbours to noise. The Minister of Aviation therefore requested a supplementary study of heliports built up to, say, 600ft. This might result in weather worse than visual minimum conditions for as much as 12 per cent of the time, so that 200ft might be a practical maximum height. Economic advantages do not accrue, in the judgment of the Committee, because the combination of a heliport and a financially worth-while building is inconsistent with the London Development Plan.

Radar Training School

SINCE 1950 Decca Radar, Ltd., has been operating a radar school, at Scantlin Pier, Blackfriars, through which over 4300 men, including 2000 masters, deck officers and radio officers, have passed. The school has now been transferred to Lambeth Pier, close to the company's headquarters building, which has been leased to Decca Radar, Ltd., by the Port of London Authority. To house the School, which was opened last week, the buildings on the pier have been reconstructed and redecorated, and on the north and south dolphins there have been erected lattice masts to carry radar aerials. Courses at the school generally occupy two days and provide operational training for masters and officers in the use of the mark of radar fitted to their ships, together with instruction on general maintenance and fault detection. Three independent radar installations from the D.11 series, which was described in THE ENGINEER of November 11, 1960, are provided for training purposes and include : a TM.969, 75kW, 16in True Motion display and a 10ft slotted waveguide which is used for instruction on TM.969 and 10cm T.M. S.2400 sets ; a TM. 939, 75kW, 12in display, 10ft slotted waveguide which is used for instruction on D. 606 and 808 and TM. 707, 909 and 939 sets ; also a D. 505, 75kW, 9in display, 6ft aerial which is used for instruction on all 9in display units. At the opening of the school it was announced that the company had received orders for 11,000 sets by July 15, the current total of radar equipped ships being estimated at 22,000, and that the equipment had been supplied to the navies of forty-one countries. Another progress point noted was that since the company pioneered True Motion radar in 1956, this design had been ordered for over 850 ships, while Decca River Radar has been ordered for over 500 river craft. Besides providing accommodation for training facilities, the pier will also berth the company's demonstration vessels M.Y. " Navigator " and M.L. " Scanner."

Sound Broadcast Translator Station at Dover

REGULAR transmissions will begin on August 8 from the new B.B.C. satellite v.h.f. sound and broadcasting station at Dover. This is the first v.h.f. satellite operating on the translator principle to come into service, although three similar television stations are already working at Hastings, Folkestone and Sheffield. The Dover station will receive the Home, Light and Third or Network Three programmes from the Wrotham v.h.f. sound station by radio and make a direct frequency change on each without demodulation. The output of each translator unit is fed direct to a pair of 1kW radio-frequency amplifiers working in parallel to ensure continuity of the transmission should a fault develop in either one of the pair. The outputs of the three pairs of radio-frequency amplifiers are combined and fed to the two halves of a directional aerial system mounted on the same tower as the aerial of the B.B.C. television station on the same site. The mean height above ground of the v.h.f. sound aerial is 375ft. Starting, operation, and closing of the Dover station will be completely automatic, but should a fault develop in the equipment an alarm is arranged to call the B.B.C. resident engineer in the district. The v.h.f. and television stations both share the site of the Air Ministry radio station on the cliffs some 400ft above Dover.

The v.h.f. transmission frequencies at Dover are 94·4 Mc/s (Home), 90·0 Mc/s (Light), and 92·4 Mc/s (Third/Network Three). Improved reception will be provided in South-East Kent, including Deal, Ramsgate, Broadstairs, Margate, Dover itself, and Folkestone. Mean effective radiated power of each programme will be 3·5kW. A further scheme covering twenty-one v.h.f. and twenty-six television satellite stations, mostly operating on the translator principle, is now being carried out to improve reception in difficult areas.

Bridgewater Canal Bi-centenary

Two hundred years ago the first boat load of coal passed along the Bridgewater Canal from Worsley to Stretford, near Manchester. The Bridgewater Canal was not the first artificial waterway, but it was the first to be built specifically to meet the needs of the then infant Industrial Revolution, and it has been said of it, truly, that it created the canal age. It had some novel engineering features, proved phenomenally successful, made a fortune for its proprietor and survives to-day in extended form, as an important feature of the industrial scene in the Manchester area.

Francis, 3rd Duke of Bridgewater, had inherited collieries at Worsley which were capable of expansion and for which nearby Manchester could provide a market, if a cheap and effective means of transport could be found. Accordingly, in 1759, the Duke obtained an Act of Parliament authorising the construction of a canal, and with James Brindley as engineer, work was started in the same year. In 1760 a further Act authorised modification of the route, and work continued so rapidly that by July 17, 1961, part of the canal was open for traffic and the first commercial boat made its passage. By the end of 1761 the waterway was carrying coal regularly to Stretford, where it was loaded into carts to complete the journey into Manchester, and the requirement of the Act, that coal should be sold in Manchester at not more than 4d. per cwt., was being met.

To get to Stretford the canal had to cross the navigable River Irwell, which it did by means of a stone aqueduct—a feat of construction which was hailed as a source of wonder by many people at the time. This crossing was, incidentally, to be superseded by another, the Barton Aqueduct, of even more remarkable construction, at a later date. At Worsley the coal mines, the *raison d'être* of the canal, were entered by the waterway, which was carried as near to the working faces as possible. In all, some 46 miles of underground canal were built, some at different levels from the main canal, and an underground inclined plane was used to transfer loaded boats from one level to another. These underground canals continued in use until late in the nineteenth century, and even to-day some of them are used for drainage of coal mines in the area.

Because of its success it was not long before the canal was extended ; in 1762 an Act of Parliament enabled the proprietor to carry the waterway down to Runcorn, and later Acts authorised further developments. When the Duke died in 1803 the ownership of the canal and collieries passed into the hands of a trust, and commercial operation continued as before. Later, in 1874, the navigation part of the trust's business was sold to the Bridgewater Navigation Company, Ltd., and in 1885 the canal was again sold, this time to the then newly-formed Manchester Ship Canal Company, in which ownership it still remains. When the ship canal was built, Brindley's stone aqueduct over the River Irwell was replaced by a steel swing aqueduct—the Barton Aqueduct—to carry the older waterway over the new ship canal.

To-day the Bridgewater Canal, operated by the Bridgewater Department of the Manchester Ship Canal Company, runs from Runcorn to Manchester and Leigh. It is a contour canal some 40 miles in total length, the only locks being at Hulme, Manchester, giving access to the River Irwell, and at Runcorn, where a connection is made with the Manchester Ship Canal. By junctions with other canals the Bridgewater provides a through waterway service to Liverpool and Manchester, the Potteries and the Midlands, and to the Cheshire salt areas. There are extensive warehouses and road and rail connections. A large variety of goods in addition to coal is carried, and there has also developed, in more recent years, a considerable pleasure traffic on the rural sections of the canal.

Water Treatment Exhibition

THE second Effluent and Water Treatment Exhibition and Convention is to be held at the Seymour Hall, London, from October 31 until November 3 next. The exhibition will be nearly twice the size of the one held in 1960. The organisers point out that increasingly severe restrictions are being imposed by river authorities on the type of effluent discharged, and that the growing volume of water required for industry cannot always be provided economically from available sources and so recovery of used water is of prime importance ; both these topics are to be well represented at the exhibition by new designs and techniques. The papers presented at the Convention will include one by a leading Russian water-treatment scientist, Oleg Lenchevsky, who recently sought political asylum in the U.K. Registrations for the Convention have been accepted from French, Belgian, German, American and Italian, as well as British, delegates. The organisers are Thunderbird Enterprises, Ltd., 140, Cromwell Road, London, S.W.7.

SHORTER REPORTS *(Continued)*

Strengthening of the Royal Navy's Anti-Submarine Forces

BY OUR NAVAL CORRESPONDENT

DURING the past three months, announcements of the commissioning or laying down of new anti-submarine frigates and aircraft have provided evidence of the Admiralty's intention to strengthen the Navy's ability to deal with attacks on the sea routes. H.M.S. " Plymouth," the fifth ship of the " Rothesay " class, was commissioned for service early in May, leaving four more of this class to be completed. At the end of that month, H.M.S. " Aurora," the fifth of the seven new general purpose type of " Leander " class frigates now under construction or on order, was laid down at the Clydebank shipyard of John Brown and Co. Her keel-laying was followed at the end of June by the launch of the first ship of her class—H.M.S. " Leander "—at the Belfast shipyard of Harland and Wolff, Ltd. Finally, at the beginning of last month two Royal Naval Air Squadrons—one old and the other newly formed—were commissioned at Culdrose and Portland respectively as anti-submarine helicopter squadrons. Within a year or two, when the seven new general purpose " Tribal " class frigates, with their revolutionary combined steam and gas turbine machinery plants, are completed, the Royal Navy will in fact have a substantial force of seventy-eight post-war designed fast anti-submarine escort vessels, many of which are suitable for escorting both task forces and merchant vessels. Of these no fewer than sixty-three were provided for under the naval rearmament programme in the early days of N.A.T.O. to deal with the menace of the modern submarine with a fast submerged speed, and consisted of thirty-three converted wartime destroyers, and eighteen " Whitby " and twelve " Blackwood " class post-war designed fast frigates. Experience gained from the first vessels of the " Whitby " class to be completed proved however that they had excellent sea-keeping qualities, good manoeuvrability and performance at high speed, and were very economical in fuel consumption. It was therefore decided to incorporate improved machinery and operational equipment and better living conditions in eight of them still to be completed and, together with the hull of H.M.S. " Coventry "—which was then under construction as an aircraft direction frigate—to reclassify these nine vessels as a new " Rothesay " class. By this time the Admiralty had concluded that it was a waste of money building frigates which could only perform one duty and ordered seven more " Whitby " class hulls for completion as frigates of a revised and advanced design, to be classified as the " Leander " class. These ships, like the very latest seven " Tribal " class now under construction, are able to fulfil a composite anti-submarine, anti-aircraft and aircraft direction role.

H.M.S. " Plymouth " (" Rothesay " class) and H.M.S. " Aurora " (" Leander " class) have the same geared turbine machinery driving twin screws, the same displacement and dimensions—about 2000 tons, length overall 372ft with a beam of 41ft—and two 4·5in guns in a twin mounting. In the " Aurora," however, the mounting is directed by a fully automatic radar-controlled fire control. She is also armed with two 40mm anti-aircraft guns in single close-range mountings and one triple-barrelled anti-submarine mortar. The " Plymouth " on the other hand has only one 40mm anti-aircraft gun, but two anti-submarine mortars. In both the " Rothesay " and " Leander " classes the 40mm anti-aircraft guns will eventually be replaced by " Seacat " ship-to-air guided missile launchers and directors. The " Leander " class will also, like the new " Tribal " class, have a long range air warning radar, carry a helicopter and be fitted with the latest equipment for detecting and attacking submarines. They will have an improved bridge structure giving greater all-round visibility, especially astern, than has been possible in previous ships with enclosed bridges. In the operations room information will be handled and presented using semi-automatic techniques. Thus, although stemming from the " Whitby " class of anti-submarine frigates, it will be seen that the " Leanders " have developed into all-round general purpose vessels, providing, with the " Tribals," fourteen ships of this type.

The Admiralty is equally alive to the importance of replacing fixed-wing anti-submarine aircraft with helicopters. Only a year ago the first two Westland Aircraft Company's gas-turbine-engined " Wessex " were delivered to the Royal Navy, and now No. 815 front-line Squadron of the Fleet Air Arm has been equipped with these new helicopters and commissioned at Culdrose for embarkation in H.M.S. " Ark Royal." The greater space and lifting capacity of the " Wessex " will thus enable helicopters to return to the " single package " concept of anti-submarine aircraft. With the " Whirlwind," one helicopter had to carry the detection equipment and another the means of killing the submarine. The " Wessex " carries both the detection equipment and the weapon. No. 815 Squadron, which has a proud history, including the attack on the Italian Fleet at Taranto and the Battle of Cape Matapan using the old " Swordfish " aircraft, has been for many years engaged in developing the Navy's air anti-submarine techniques. It is thus very appropriate that they should be the first Fleet Air Arm Squadron to be equipped with a first-rate anti-submarine helicopter. The new helicopter squadron—No. 77—recently commissioned at Portland is equipped with four different types—" Wessex," " Whirlwind," " Dragonfly " and " P.531 " helicopters. It is the first air squadron in the Royal Navy to be specifically commissioned and equipped for the task of training and trials. The " P.531 " is particularly suitable and has been developed for operating from ships of the frigate type and will be used in both the " Leander " and " Tribal" class.

Vee Form High Power Diesel Engine

FOLLOWING months of research and a study of the international market, the National Gas and Oil Engine Company, Ltd., has announced the development of a Vee-form version of its " F " series of diesel engines. This new concept will extend the range of the " F " engines, already available from 285 to 1550 b.h.p., to 3100 b.h.p. at 600 r.p.m. in sixteen-cylinder form. The " F.V." unit will be suitable for operation on diesel oil, gas, or as a dual fuel engine, and it is expected to go into production next year. The engine will have the same bore and stroke, 12in by 15in, as the present in-line unit, and will incorporate many of its design items, while the combustion characteristics of the " F " engine will be maintained by the use of the present cylinder head, piston and cylinder liner. Many other parts will be common to both series of engines, so that a common stock of spares will suffice.

In designing the new engine a number of advanced techniques have been employed, including photo-elastic analysis of the crankcase and cylinder block carried out on models prior to the construction of twin-cylinder prototype engines. Articulated connecting rods will contribute to compactness, and strain gauge measurements have been made on connecting rods of alternative designs in an hydraulically loaded static test rig, and the rods are also being tested in the prototype engines to assess the most suitable design from the aspect of cost and reliability.

[Reply Card No. 1131]

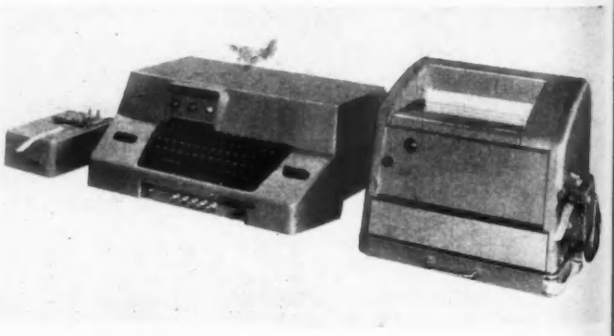
Punched Tape Verifier

To meet the demand created by computing and data processing for means of verifying six-track and seven-track punched paper tape, a new version of the Creed Model 90 tape verifier has been introduced by Creed and Co., Ltd., Telegraph House, Croydon, Surrey. This provides means for automatically detecting and eliminating operator errors in the punching of five-, six- or seven-track tapes at speeds up to fifteen characters per second. The verifier consists of interconnected units of Creed punched tape equipment, namely a Model S4136 multi-wire keyboard, a Model 92 tape reader, a Model 25 tape punch and a power pack. It is also available as a verifier-reproducer set as illustrated, with a page printer in addition to the other facilities.

Operation of the verifier is based on automatic comparison of two separate transcriptions of the same source data. The unverified tape is fed into the tape reader and the data typed out a second time from the source document. The units are electrically interconnected in such a way that when the code produced by the second typing agrees with that already punched in the original tape, the same character is punched in a second tape. When the two codes do not agree, the keyboard locks and nothing is punched on the second tape. After determining whether the error was in the first or second typing, the operator takes appropriate action so that the correct character is punched in the second or verified tape.

The verifier-reproducer set incorporates a Model Seventy-five teleprinter with tape punch attachment in place of the Model 25 tape punch; this adds page printing, tape editing and tape interpreting facilities. The keyboard unit of the verifier-reproducer incorporates a number of new features. One of these is a high-speed " skip " facility which enables the operator to make the tape reader pass over any redundant data and stop at the first character after the unwanted characters. Another feature is the inclusion of warning lamps which give a constant indication of the parity or disparity of the character being verified.

[Reply Card No. 1115]



Equipment for verifying punched tapes used in computer and data processing systems

Dual-Zone Temperature Controller

A MERCURY-IN-STEEL, on-off, temperature controller, with independent circuits allowing control at any two points through one instrument, has been produced by the British Rototherm Company, Ltd., Merton Abbey, London, S.W.19.

Each controller circuit consists of alloy steel Bourdon tubes, capillaries and temperature sensitive bulbs, operating mercury switches

Temperature controller with independent circuits and controls for switching heating supplies in two zones

rated up to 30A at 230/250V a.c. The differential is fixed, but varies according to switching capacity. Indicator lamps, seen in the illustration, and bottom-entry electrical conduit are standard. Temperature ranges are available between minus 20 deg. Fah. and plus 1000 deg. Fah. (minimum coverage 100 deg. Fah.). The case is aluminium alloy and the standard capillaries are 10ft copper sheathed with mild steel bulbs screwed ½in B.S.P.

[Reply Card No. 1121]

Peripheral Photography for Research

A "PERIPHERAL" camera that takes a continuous all-round view of an object, as it would be seen if the surface was laid out flat, has been developed by the Thornton, Cheshire, Research Centre of Shell Research, Ltd. It is shown in the illustration photographing a globe of the world to produce a print like a wall map. Previous methods of periphery photography have been limited by the size and shape of the object being photographed. The Thornton camera overcomes these limitations and also enables the inside surfaces of hollow objects to be photographed. The camera can photograph complex and irregularly-shaped objects like skew gears. It may also be used to compress lengthy traces produced by recording instruments so that cyclic irregularities can be identified and compared easily. The camera unit is mounted at Thornton on an existing standardisation bench which has calibrated settings for camera and lighting. It has three separate parts : a rotating turntable upon which the object to be photographed is placed ; a traversing plate-holder fitted to a conventional plate camera ; and an electrical control unit. In this way the space required by the camera is kept to a minimum. It is also possible to use the equipment away from the studio at any location where a suitable power supply is available. Periphery photography offers many advantages over conventional methods. For instance, the whole surface area of an object can be put on one negative ; the narrow angle of view reproduces colour more faithfully ; surface texture details, wear marks and small surface deformations on curved surfaces, appear clearly ; irregular curves such as the teeth of skew or hypoid gears appear in plan form as a continuous strip showing the drive faces of each tooth.

[Reply Card No. 1120]

Photographing a globe of the world with a peripheral camera. The globe is on a rotating stand, and the camera is fitted with a traversing plate holder

Small-Diameter Coaxial Telephone Cable

WHILE multi-channel telephone cable costs can be reduced by using coaxial conductors of less than the usual 0·375in diameter, the greater loss makes more repeaters necessary. With the advent of the low-consumption transistorised repeater which can be buried in the ground instead of needing a small building to house it, the situation is changing, and in Sardinia it has been found economic on a telephone route of relatively low traffic density to use 0·163in tubes with repeaters every 12,000ft.

The new system extends between Golfo Degli Aranci, Sassari and Cagliari, approximately 226 miles. It was designed by Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2, and installed by Societa Italiana Reti Telephoniche Interurbane, S.A., Milan. Three hundred telephone circuits can be provided on each 0·163in diameter coaxial cable pair, of which there are four in a cable of similar construction to the S.T.C. type 163 cable now being supplied to the British Post Office, British Railways and telephone administrations overseas. For the Sardinian installation the cable was manufactured by S.I.R.T.I.

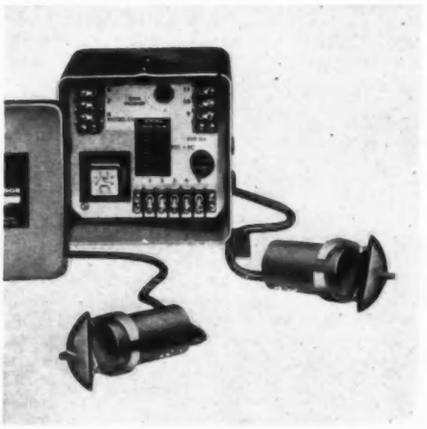
The frequency spectrum on each coaxial tube extends from 60 kc/s to 1300 kc/s, accommodating 300 speech channels each from 300 to 3400 c/s ; the overall system has been designed to meet the C.C.I.T.T. noise specification for routes up to 1600 miles (2500km) in length. With the 12,000ft repeater spacing the cable loss to be compensated is of the order of 27dB at the top frequency transmitted. An automatic pilot control is incorporated in the system to compensate for changes in cable attenuation due to varying ground temperatures.

The repeater equipment comprises terminal, main (power feeding) and dependent repeaters. Junction transistors are used throughout for low power consumption and heat dissipation. The terminal and main repeaters are rack mounted, but the dependent repeater is designed to be accommodated in a buried housing which may contain one or two both-way repeaters. With the use of transistors, a compact unit with low current drain has been achieved, suitable for unattended operation. Electrical connection of the repeater to the coaxial tubes is made by means of flexible plug-ended cords to facilitate repeater replacement when required.

Power to operate dependent repeaters is fed over the coaxial tubes from the nearest main repeater or terminal station by passing a stabilised direct current through the repeaters in series. A device is provided to enable faults in dependent repeaters to be located from terminal and main stations using the interstice pairs within the cable.

Ultrasonic Sensor System

DISCRIMINATION between the presence or absence of objects in the path of an ultrasonic beam is provided by the "Sonac" system available from Westool, Ltd., St. Helen's Auckland, Co. Durham. The system was developed by the Delavan Manufacturing Company of West Des Moines, Iowa, for whom Westool, Ltd. is the sole licensee for the United Kingdom and Eire. Its principal components are a transistorised amplifier, a plug-in output relay, two hermetically-sealed acoustic sensors, and a power supply. The two sensors are connected to the control unit (illustrated) which contains the relay and

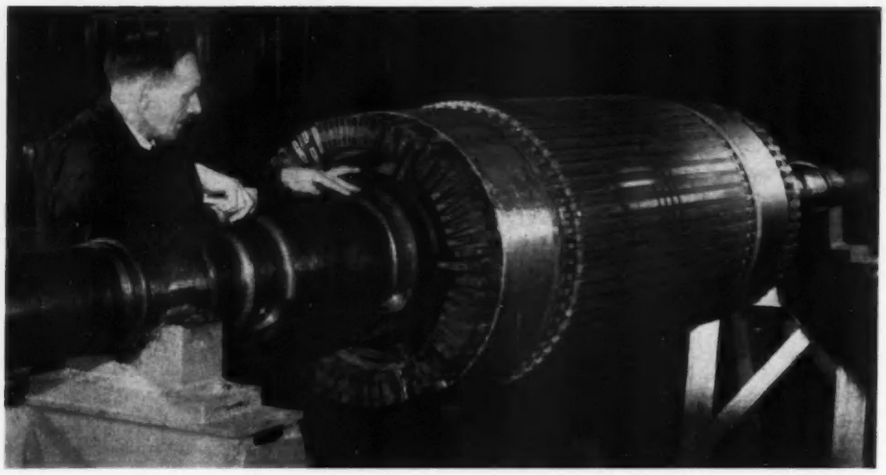


Control unit and sensors of ultrasonic counting and detecting systems

power unit. Ultrasonic waves are generated by feedback between the sensors, one of which is connected to the input and the other to the output of the amplifier. The sensors may be located so that the beam between them follows a direct path, interruption of the beam being arranged to energise or de-energise the relay as appropriate. Alternatively, they can be located so that oscillations are established when an object reflects the sound waves from one sensor to the other. Two modified sensors, the coupler and "focaliser" sensors, are available for special applications. The coupler sensor confines the sound waves to a small area for transmission through flexible rubber hose or metallic pipe to reach locations too restricted for the general-purpose sensor installation. The "focaliser" sensor assembly is available to produce sound beams of a very narrow angle and to receive sound energy similarly, the beam pattern being elliptical (10 deg. and 20 deg.) as opposed to the conical pattern (50 deg.) of the general-purpose sensors. They are used for applications requiring beam paths of more than 20ft, or for narrow concentration of the beam in paths of less than 20ft.

The standard length of cable between sensors and control unit is 10ft, although cable up to 100ft in length can be used where path lengths between sensors do not exceed 10ft.

[Reply Card No. 1117]



Rotor of a 2560 h.p., 3000 r.p.m. slipring motor for boiler feed pump motor at Belvedere power station. The rotor conductors are hollow for direct air cooling

Large Electric Motors with Direct-Air-Cooled Rotor Windings

OUR illustration shows the hollow conductors on the rotor of a large high-speed slipring motor designed and manufactured by The English Electric Company, Ltd., Strand, London, W.C.2, for driving boiler feed pumps in power stations.

Constant speed squirrel-cage motors running at 3000 r.p.m. have for long been the standard drive for centrifugal boiler feed pumps, but motor sizes have been increased considerably with the higher pressures in larger modern boiler plants. Variable speed drives are now required for these larger units and the slipring motor is generally used because of its low cost, simple control and low starting current. The design of a 3000 r.p.m. wound rotor machine of 2000 h.p. or more introduces difficulties in the cooling of the rotor end windings while providing adequate support for them.

The solution adopted by English Electric is the direct air cooling of the conductors, which are manufactured from hollow rectangular section copper ; cooling air enters at each end of the conductors. Direct cooling also reduces the cooling air quantity to a minimum, so that the motor efficiency is improved.

Eight machines using rotors of this kind are being commissioned for driving the main boiler feed pumps at two C.E.G.B. power stations. Four of the motors, for Willington " B," are each rated at 6200 h.p. and four, for Belvedere, at 2560 h.p. Although these large high-speed slipring motors have been developed for driving boiler feed pumps they can also be used for other high-speed industrial drives needing speed variation and/or a low starting current.

[Reply Card No. 1130]

Thyratrons for Pulse Switching

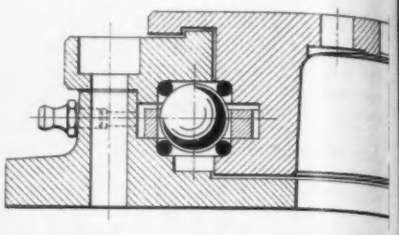
Two new hydrogen thyratrons, CX1140 and FX297, for applications in radar transmitters, linear accelerators and other pulse switching equipments, are announced by the English Electric Valve Company, Ltd., Chelmsford, Essex. The CX1140 is designed for use as a pulse modulator switch and the FX297 as an inverse diode. Both valves have a new design of hydrogen reservoir which is electrically in series with the heater and allows the correct hydrogen pressure to be maintained. With this system an auxiliary controlled reservoir supply is not required, and a considerable increase in operating life of the thyratrons is achieved.

The CX1140 is a tetrode with characteristics enabling it to be used in parallel for switching high powers. It may also be used for switching long pulses provided the mean current is not exceeded. The valve is a direct replacement for the CX1119 but has an improved heating factor and a longer operating life due to the reservoir. The FX297 has a long recovery time and is therefore suitable for use as a triggered inverse diode (backwash diode) in high-power long pulse length modulators. Triggering may be effected through an insulated toroidal pulse transformer in the anode circuit of the pulse modulator switch tube. Since the FX297 has to hold off an inverse voltage, the necessary low gas pressure can only be maintained at the correct level throughout life by means of the hydrogen reservoir.

[Reply Card No. 1122]

Large Wire-Race Ball Bearings

A RANGE of precision bearings in six sizes from 18in to 40in diameter is now available from the Roballo Engineering Company, Ltd., 43, Dover Street, London, W.1. These bearings have rolled flanged ring sections of medium carbon steel, similar to those used for the firm's slewing rings, but the ball races, instead of being flame hardened on the base metal, consist of high-grade spring steel wires. These wires, as shown in our diagram, have spherically ground tracks, and they are inserted in accurately machined grooves, an arrangement which provides a rigid construction with four lines of ball contact. It is claimed that these bearings have accuracies of the order of 0·002in radial and axial runout.



Construction of a ball bearing with inserted spring steel wire-races giving four lines of contact.

With the new bearings, a conventional housing is not required, and they can be mounted by bolting through the flanges to a machined surface.

[Reply Card No. 1102]

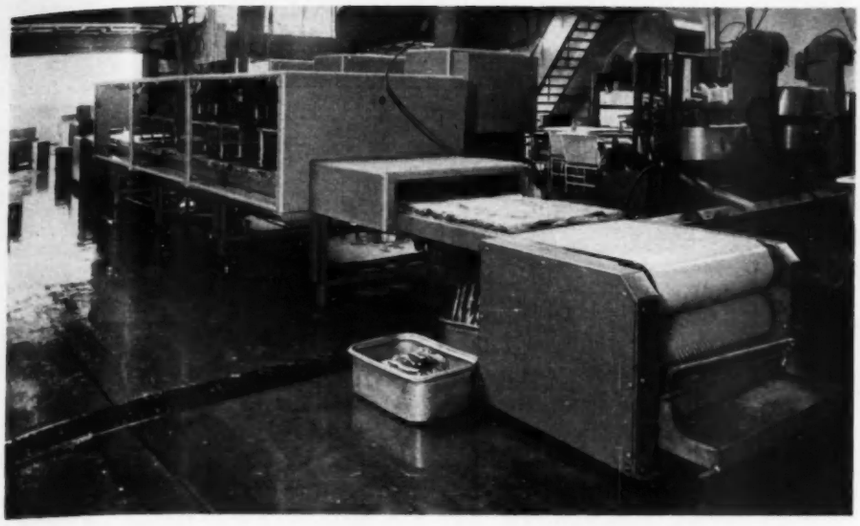
Shuttle Cars

FOLLOWING successful trials with a prototype shuttle car in the ironstone mines of the United Steel Companies, Ltd., nine further cars to the same design have been ordered from Qualter Hall and Co., Ltd., of Barnsley, for service in the ironstone mines at Dragonby and Stanton, near Scunthorpe. The new cars, the diesel engine-driven prototype of which is illustrated on this page, are equipped for battery-electric traction, and a maximum load of 15 tons can be carried at a maximum speed of 4 m.p.h. The high capacity batteries (854 AL) used in these vehicles were recently introduced by Chloride Batteries, Ltd.

The cars have a clearance of 18in at the lowest point and 2ft at the discharge end. Along the base of the central hopper of the cars is fitted a round link scraper conveyor driven by two 16½ h.p. motors. Similar motors are used in both the conveyor drive and the traction of the car. Power assisted steering and servo-assisted disc braking are provided to reduce driver fatigue, and from his position in one corner at the rear of the vehicle the driver has a clear view during the loading and unloading operations.

[Reply Card No. 1125]

Prototype diesel electric shuttle car for ironstone mine



Radio-frequency dielectric heating installation for defrosting frozen fish

Electronic Defrosting Installation

THE deep freezing of freshly caught fish has enabled the fishing fleets to be employed more economically in that the return to port is no longer dictated by the need to prevent deterioration of the catch. However, this freezing at sea has created a demand for an economical and reliable method of defrosting for processing. This has been done in the past by thawing in warm water or by the circulation of hot air, both methods being uneconomical and very slow and both suffering the disadvantage of uneven heating in depth. The surface of the fish tends to become overheated, leading to rapid deterioration, while incomplete defrosting at the centre causes the fish to tear when being separated. To solve this problem the Torry Research Station of the D.S.I.R. set out to develop a defrosting technique which would provide economical, controlled and consistent thawing throughout the slab of fish at a high rate and be capable of operation by unskilled personnel. The most promising possibility was found to be dielectric radio-frequency heating in which the material to be thawed is placed between two plates, to which radio-frequency energy is applied, generating heat by the alternating electric field between the plates. In this system the material to be thawed acts like a dielectric in a condenser and is heated uniformly throughout its depth and likewise the temperature increases uniformly. There is no danger of overheating, and variation of the energy fed into the system or of residence time accurately controls the final temperature.

The first commercial plant embodying the system has been designed and built by the Process Heating Division of Pye, Ltd., Cambridge, and has been installed at the Grimsby fish factory of the Ross trawler-fishing and frozen food groups. Our illustration shows the general layout of the installation with the slabs of frozen fish passing through the generator ovens. The plant is based essentially on fully proven industrial heating equipment suitably modified to deal with the new medium ; and the process is continuous. Built on the modular or unit system the equipment consists of three tunnel ovens in series, each having its own 12kW industrial radio-frequency generator energising a balanced pair of aluminium electrode plates. A continuous conveyor belt 32in wide carries the frozen fish slabs through the ovens and beneath the electrodes at a speed which can be varied to suit the fish being handled. Cleaning of the belt is effected by a rotary nylon brush and water jets. The modular system adopted permits of greater throughputs by adding further generator ovens and by increasing the belt speed accordingly. Each generator is of rugged design and employs a water-cooled industrial power triode valve in a Colpitts circuit and operates on the internationally-assigned Industrial Scientific Medical band of 27·12 Mc/s. The associated pair of electrodes is energised by the generator from a balanced output circuit, so that there are no earthing difficulties with the fixed lower electrode, and a local parallel tuned circuit restricts heavy circulating currents to the vicinity of the electrode assembly. The only operational adjustments are to match the speed of the belt with the energy input required for the type of fish and to tune the electrodes by variation of the air gap.

Early results have demonstrated the consistency of the process and frozen slabs of herrings, 2½in thick and weighing 10 lb, loaded at a temperature of between −20 deg. and −30 deg. Fah., traverse the ovens in about twelve minutes and emerge just below freezing point. Normally there is less than 1 deg. variation in temperature of any two points in a slab or between slabs. Other advantages of the process include low processing cost, due largely to the almost complete absence of waste heat, and the ability to accommodate sudden changes in demand by means of the rapid throughput.

Tipped Insert Beak Picks for Drum Shearers

AN announcement of interest to mining engineers is that Wickman, Ltd., Bottrill Street, Nuneaton, is now supplying for universal application on drum shearers a slug-insert beak type shearer pick. This pick, illustrated below, was developed by extensive trials in the East Midlands Division of the National Coal Board and it has led to substantial reductions in power requirements together with an increase in the large-coal content. Initial tests with this form of insert were made in a colliery in No. 1 Area of the East Midlands Division on a face with a cutting length of 138 yards which was adversely affected by a fault of 2ft displacement. The floor was also hard and undulating and under such conditions it was inevitable that a high usage of the conventional type of shearer pick would result.

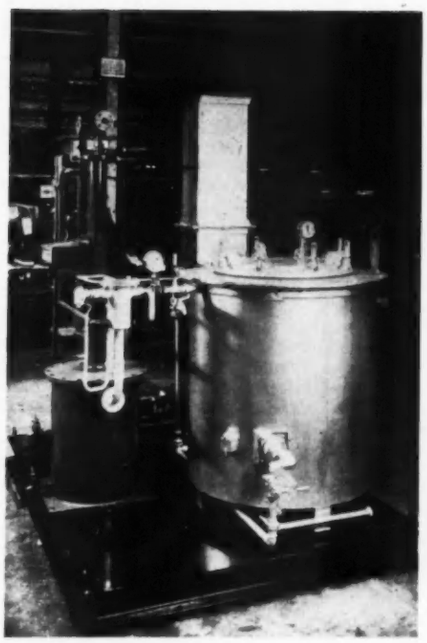
The introduction of the slug-insert beak shearer led to a considerable reduction in the total number of picks used, and the time lost in replacing pick discards was reduced to a minimum. Ammeter readings taken during the cutting period showed that the machine was consistently operating at between 80A and a maximum of 90A as opposed to the previous rating of 80A to 120A. In the course of the tests, carried out by the National Coal Board personnel, it was found that 257 conventional type picks had to be discarded in cutting 8418 yards at a cost of 5·8d. per ton of coal produced. In cutting 5107 yards, only twenty-eight slug-insert beak shearer picks were discarded, at a cost of 2·4d. per ton of coal produced despite a higher initial cost of pick.

[Reply Card No. 1119]

Beak type shearer pick fitted with "Wimet" tipped slug insert

Rubber De-Bonding Plant

THE 4-cubic-feet-capacity Holmes-Andre de-bonding plant seen in our illustration operates on the same principle as earlier plants, namely destructive distillation in a closed vessel, but differs in certain instances. Special consideration was given in the design to the problem of preventing the fouling of vapour pipes and the double ended 1 h.p. motor driving the air blower also drives a pump which circulates distillate oil through the system. This irrigates the off-take piping and also washes the rubber vapour in a scrubber cooler and maintains a constant level in a seal tank. To deal with a short section of pipe that cannot be irrigated a built-in rodding device is incorporated. The equipment is compact and is accommodated on a rectangular base having an area of 48 square feet, and all that is required at installation is a gas or oil supply for heating the retort, water and electric services. However, the provision of a small-bore low-pressure steam supply enables the retort to be emptied while hot so that operating times are reduced and a saving in fuel costs effected. The rubber content of the items to be de-bonded largely determines the time of an operation and a typical load of 2in by 3in by 1in rubber blocks, with a mild steel bracket stud bonded in, can be treated in 4½ hours from cold, while a second charge inserted while still hot can be de-bonded in 3¼ hours. Gas consumption averages 122 cubic feet per charge.



Rubber de-bonding plant of 4 cubic feet capacity

SHORTER REPORTS *(Continued)*

Pneumatic Rotary Actuator

A SMALL compressed air-operated actuator for use on machine tools and other equipment made by Ledex, Inc., of the United States, has been introduced into this country by N.S.F., Ltd., 31–32, Alfred Place, London, W.C.1. This actuator converts linear motion imparted by the pneumatic system into a rotary movement at the shaft through a system of balls running in inclined races, and the shaft can be coupled directly to the load.

Rotary actuator which provides a torque output of 6·5 lb in over 90 deg. of shaft rotation with an air supply pressure of 120 lb per square inch

The actuator will be available in a range of sizes developing torques between 1·35 lb in and 94 lb in. The model shown in the illustration, which has an overall size of 1½in by 2in, provides a torque output of 6·5 lb in for a maximum operating pressure of 120 lb per square inch. It gives a 90 deg. rotation of the output shaft in thirty to forty milliseconds, the air displacement being 0·16 cubic inch. Torque is uniform through the full rotary stroke and speed is dependent upon load.

All the working parts of the actuators are totally enclosed and they consist of a short stroke piston with an integral rotor plate and output shaft. The unit is self lubricating and does not need special air line arrangements.

[Reply Card No. 1118]

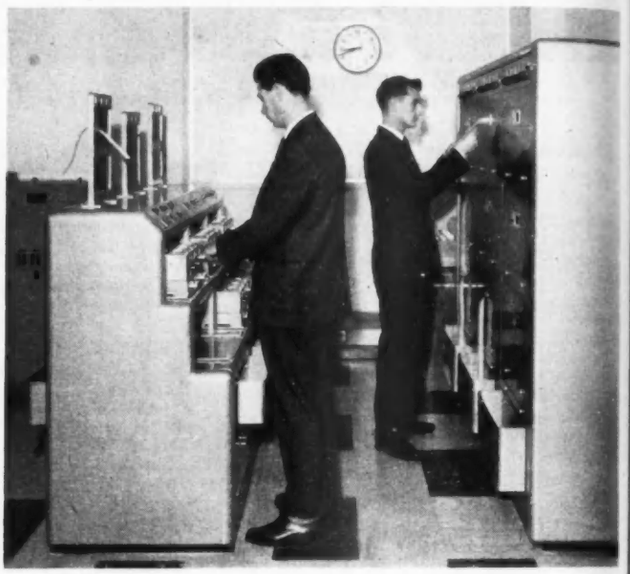
Private Wire Teleprinter Network

TWENTY-FOUR offices of the Aluminium, Ltd. of Canada (Alcan) group of companies have been linked by a private-wire teleprinter network based on a tape relay centre in London. From here connection is provided by trans-Atlantic cable with the Montreal centre of the Alcan teleprinter network in North America. All the teleprinter equipment of the United Kingdom system was manufactured by Creed and Co. Ltd., Telegraph House, Croydon, Surrey, and supplied on a contract rental basis with full maintenance. Electronic group switching units were supplied by the associated company, Standard Telephones and Cables, Ltd., to a jointly-engineered S.T.C./Creed design.

The London relay centre (illustrated), situated at Aluminium Canada House, Berkeley Square, is linked by G.P.O. private-wire circuits to six area groups in different parts of the country, each group consisting of up to six offices. This grouping of stations with common lines to the London relay centre, which serves as a transfer point for all messages exchanged between offices in different groups, enables network communications to be handled with the lowest possible circuit costs.

Each group has its own transistorised switching unit installed in one of the offices, which directs messages automatically to destination under the control of a code punched in the message tape. Messages may be routed direct to another office in the same group, or to the London centre for passing to an address in a different group. Route selection is carried out entirely by transistor circuits, but the final connection to the required line is made by relays.

All offices in the network have a set of message originating, sending and receiving equipment comprising a Creed Model 7P/N keyboard perforator and Model 6S/6-M automatic tape transmitter, mounted side-by-side on an equipped desk unit, together with a Creed Model 75 teleprinter receiver, separately mounted. Messages for transmission are encoded in five-track punched paper tape by off-line typing on the perforator keyboard, the operator inserting the address code in front of the message. The leading end of the tape is then put into the automatic transmitter and a desk "call" button is pressed. This action signals the local group switching unit that a message awaits attention.



Receiving reperforators (right) and transmitters (left) at the private teleprinter network London relay centre

The local group switching unit continuously scans the lines it serves for any message awaiting transmission, either from one of its own local group of offices or from the main London message centre. Messages are handled one at a time, the unit checking first with the main relay centre to ensure that incoming messages from other area group offices receive priority. When a message is accepted by the local unit, transmission proceeds automatically at 66 w.p.m.

The signals received by the switching unit are also transmitted back to the sending station's teleprinter which provides a page printout of the message.

Should another station in the same area group already be sending or receiving, the tape in the transmitter will not feed through the machine until the switching unit is free. Apart from the stationary tape, a further indication that the switching unit is busy is provided by arranging for the teleprinter receiver at each local office to print out the address details of messages transmitted by all the others.

Inter-group messages switched through to the London relay centre arrive there on a series of six Creed Model 86 printing reperforator receivers housed in two metal consoles. These code-punch the incoming message and also print a plain language interpretation on the tape for speedy indentification. A relay centre attendant notes the final destination of the message, tears off the completed tape and transfers it to the outgoing section. Since that part of the address code which caused the message to be routed initially to the centre is no longer required, it is torn off, leaving the final destination code punched in the tape.

Two Model 71 three-gang transmitters are employed in the outgoing section of the centre, both having three message-transmitting heads, one for each of the circuits radiating to the six area groups. After putting the tape in the appropriate transmitter head, the operator presses a button, setting up the "call" condition. Transmission proceeds automatically immediately the call is accepted, the distant electronic switching unit routeing the message to its final destination.

[Reply Card No. 1116]

Synthetic Organic Acid Group

THE Shell International Chemical Company, Ltd., states that extensive research by the Shell laboratories in Amsterdam has produced a new group of synthetic organic acids which is now available from a pilot plant. The acids will be produced on a commercial scale at the beginning of next year in a plant now under construction at the company's Pernis refinery at Rotterdam. These acids, marketed under the trade name "Versatic," are similar in some respects to other organic acids but possess additional properties which will find important applications in surface coatings, plastics, rubber, metallurgical and other industries.

"Versatic" acids are produced from olefins, carbon monoxide and water by a process based on the work of Dr. H. Koch. A full range of acids will be made available eventually, but the present samples are a blend of C_9, C_{10} and C_{11} monocarboxylic acids. They are fully saturated and there are none having two alpha hydrogen atoms and only 10 per cent containing one alpha hydrogen atom, while some cyclic material occurs among the remaining 90 per cent. This high degree of branching in the structure of "Versatic" acids provides great stability against hydrolysis of the esters which can be made from them. The products, which contain 93 per cent acid and 7 per cent neutral oil, are colourless and almost odourless.

Narrow Boat Showroom for Telecommunication Equipment

A DISPLAY of telecommunication and allied equipment in the converted narrow boat "Taplow" was opened at Little Venice, Paddington, on July 26 by the Rt. Hon. Hon. J. F. Erroll, M.P., Minister of State, Board of Trade. In mid-August the "Taplow" will leave London for a three-year tour of inland waterways during which most of the industrial centres of the Midlands will be visited. The exhibition and tour have been organised by Communication Systems, Ltd., Norfolk House, Norfolk Street, London, W.C.2, a member of the A.T.E. group of companies. In the accompanying illustration

Colliery telephone and dictation recording equipment in the "Taplow" floating show room

of the "Taplow" floating showroom an installation of the A.T.E. telephone dictation recorder is seen on the right, and of the Type 58 private automatic telephone exchange and telephones for colliery use on the left.

The telephone dictation system provides automatic selection of a free recorder when the appropriate number is dialled on a normal extension telephone. Operation is under fully automatic remote control from desk push-button units measuring 3½in by 2in by 1¼in. Normally the recorders would be installed in a typing pool, and each has a telephone handset for ordinary communication when necessary, but the automatic system enables dictation to be recorded and stored irrespective of whether staff are present in the pool or not.

The Type 58 telephone display is a working installation comprising automatic telephones, a fifty-line exchange, and a priority panel. The instruments are intrinsically safe, operating on a 24V non-earthed battery. A distinctive feature of the exchange is that both automatic and magneto operation are provided for. Up to 100 party lines can be accommodated and are rung selectively by a three-digit dialling system in which the first digit determines the ringing code for the extension required while the other two select the line. Up to four instruments can be connected to each party line. Calls to other lines are made by turning a generator handle until dialling tone is obtained, and then dialling in the usual way. Calls within a party line are made by turning the handle to give the required number of code rings. Calls to the priority panel are made by operating a push-button which initiates an audible warning and lights line identification lamps on the panel. The attendant answers by plugging into the line concerned, overriding any other traffic on the line. Emergency calls can be made similarly from the panel.

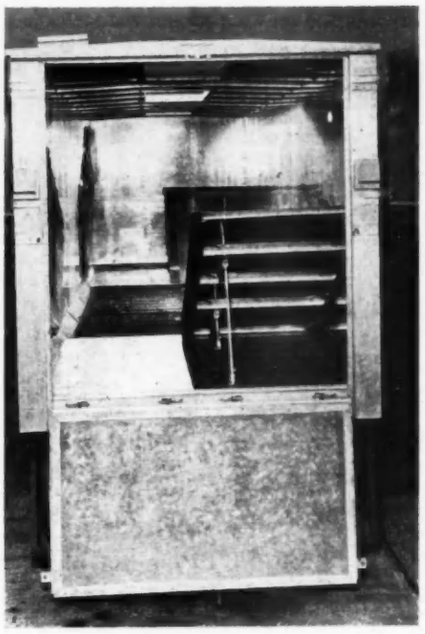
A further exhibit in the "Taplow" is the A.T.E. crystal chronometer, comprising a crystal-controlled oscillator generating a basic frequency from which binary dividers produce pulses at intervals of one second, thirty seconds and one minute. Developed originally as an alternative to the pendulum form of master clock, the chronometer has been widely adopted for a variety of purposes, including astronomical measurements. Its versatility is increased by the fact that a portable version can be operated on dry batteries.

Conversion of the "Taplow" was carried out by the Willow Wren Canal Carrying Company, Braunston, near Rugby. Propulsion is by a 12 h.p. Petter diesel engine, and a 4kW Lister diesel-alternator set provides the electrical power. The vessel has a cabin forward of the showroom and living accommodation aft.

Variable-Configuration Trailers

WE have received details of two new special-purpose trailers, one custom-built and the other a prototype.

Bonallack and Sons, Ltd., have built for and in collaboration with R. and W. Paul, Ltd., of Ipswich, a malt transporter on a B.T.C. "Four-in-line" semi-trailer. The volume of traffic in malt is so small as to demand a vehicle which can carry malt either bagged or in bulk, and the



Malt carrier with the two starboard flaps folded down and strutted as for bulk carriage

Bonallack body has both a tail-board and doors and a hopper and roof filling apertures. The floor of the body, which is principally of "Dekaloy" extruded planking, has a centre section of metal mesh, below which is the hopper. When the body is to be used as a bulk carrier, there are folded down from the sides of the body four flaps which extend the faces of the hopper up to the back and front of the body, and prevent bulk malt settling on the floor whence it would not unload by gravity. When the flaps are stowed, the interior is virtually unobstructed. The tail-board can be used for load carrying, being supported by tubular beams telescoping out of the main girders of the bogie. The body weighs slightly over 4 tons, including spare wheels for trailer and prime mover, and can carry 15 tons of malt.

[Reply Card No. 1123]

D. H. Morgan (Engineers), Ltd., Wrecclesham, Farnham, Surrey, has recently completed tests on a 1-ton trailer designed to afford expeditious loading of machinery and equipment. The trailer, which in the prototype has a platform 10ft by 5ft, has independent suspension by trailing forks and quarter-elliptic springs; this would appear to render the camber thrusts unstabilising with respect to side forces. The springs are clamped in arms which can be rotated by hydraulic rams. With this mechanism the platform can be lowered to rest on the ground, when the loading height becomes 5in, or raised for travel when the ground clearance is 9in. The rams are energised by a hand pump on the trailer.

[Reply Card No. 1124]

Synthetic Rubber for Mechanical Applications

THE Dyestuffs Division of Imperial Chemical Industries, Ltd., has introduced a polyurethane rubber and curing agent for applications where mechanical properties are at a premium.

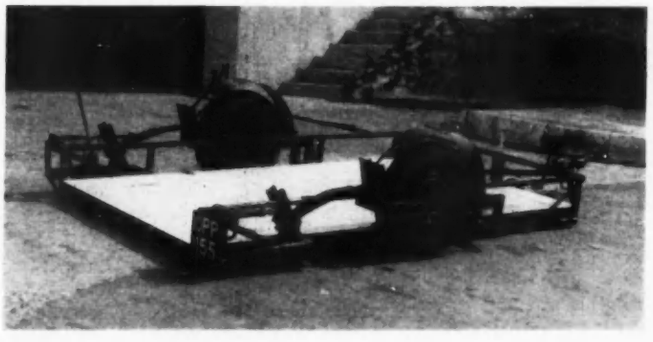
"Daltoflex 1" is a polyurethane raw rubber designed for processing on conventional rubber machinery. It is cured by means of "Suprasec M," a liquid isocyanate compound of high boiling point whose low vapour pressure ensures freedom from any toxic hazard during processing. Hard rubbers of outstanding physical and chemical properties are obtained.

Curing is normally carried out under pressure at 150 deg. Cent. for ten to twenty minutes, followed by a short oven cure at 110 deg. Cent. With these new products, in contrast to natural rubber or other synthetic rubbers, an accelerator is not essential for curing. The cured compounds obtained are markedly superior to natural and earlier synthetic rubbers in tensile and tear strength, abrasion resistance, solvent resistance and in resistance to oxidation.

"Daltoflex 1" compounds are recommended for such articles as oil seals, shoe soles and heels, solid tyres for factory trucks, diaphragms, and for general mechanical applications where a high level of physical properties and/or good solvent resistance is necessary. Extensive use in such applications is anticipated. Unlike cast polyurethane rubbers, "Daltoflex 1" compounds may be considerably reinforced by filling with carbon black, silica or other fillers, using conventional rubber processing techniques

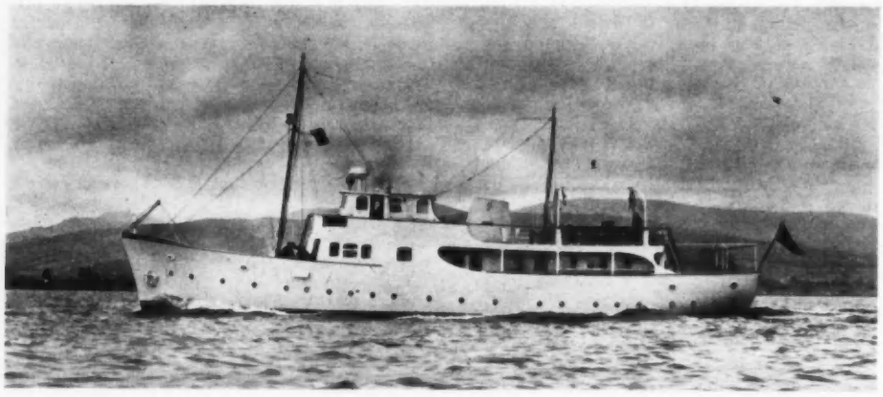
In "Urethane Chemicals Literature No. 6," I.C.I. Dyestuffs Division offers full data on the processing of "Daltoflex 1"/"Suprasec M" rubbers, together with tables of data on the physical properties of typical cured compounds.

[Reply Card No. E1128]



Low-loading trailer with running gear retracted; immediately above each ram is the strut that supports the spring bracket in the raised position. The pump can be distinguished by its handle

SHORTER REPORTS *(Continued)*



Yacht "Maureen Mhor" on trial

Twin-Screw Motor Yacht "Maureen Mhor"

RECENTLY completed by Yarrow and Co., Ltd., at its yard at Scotstoun, is the twin-screw motor yacht "Maureen Mhor" which can be seen on trials in our illustration, and has been constructed, under the supervision of G. L. Watson and Co., to Lloyd's classification for hull, electrical installation and machinery. Except for the deckhouse, housing the wheelhouse and chart room, and the bulwark forward on the upper deck, which are of aluminium alloy, steel has been used throughout to build the yacht. Welding and riveting have been used as methods of joining, and below the waterline the shell butts are welded and the seams riveted, while above the waterline all butts and seams have a single inside strap and are flush riveted to give a smooth finish. Subdivision is effected by five watertight bulkheads and both the main and upper decks are laid with 2in thick Burma teak. The main characteristics of the yacht are : length over all 105ft ; length on waterline 96ft ; breadth moulded 21ft ; depth moulded 10ft 9in ; load draught 8ft 6in ; speed 12¼ knots ; machinery of 400 b.h.p. Thames measurement 180 tons.

There are five cabins, the spacious and well-fitted owner's suite being arranged on the cabin flat immediately forward of the engine-room and occupying the full breadth of the ship. The suite incorporates a separate bath room and a small hall from which an "L" stairway rises to the fore and aft inside passageway in the house on the main deck. Three two-berth guest cabins are placed on the cabin flat aft of the machinery spaces and all have private toilet facilities and two have baths. These cabins open on to a lobby from which an "L" stairway rises to the lounge at the aft end of the house on the main deck. Also on this deck is a single-berth cabin arranged on the port side between the engine-room entrance and the lounge, while at the forward end of the house is the dining saloon having a teak table to seat eight. Aft of the saloon to port is the galley, equipped with an oil-fired cooker, refrigerator, &c., and further aft is the engine-room entrance in which is placed a large capacity deep freeze cabinet. A companionway forward on the main deck gives access to the crew's quarters on the cabin flat, and these include a cabin for the captain, two two-berth cabins, a small galley and a mess space in which there is an additional emergency berth.

The wheel-house is fully equipped with modern aids to navigation and in the chart room is a bed-settee. A stairway leads down to the inside passageway in the main deck-house. There is power-assisted steering and to reduce the amplitude of roll two sets of Denny-Brown gyro-controlled, non-retractable, stabilising fins are fitted. Other equipment includes an electric and hand-operated windlass, while the boat complement consists of a 14ft by 5ft motor launch and a 12ft by 4ft 8in dinghy carried in davits and associated with electric winches. Three ten-man inflatable liferafts are also provided.

Propulsion is by two handed Gardner Mark 8L3.B eight-cylinder, unidirectional diesel engines each developing 200 b.h.p. at 1000 r.p.m. and driving a 4ft 6in diameter propeller through a Gardner 3 to 1 reduction gear. The propulsion units have a 24V electric starting motor and a belt-driven charging dynamo, and there is a lead-acid battery which is also used for starting the auxiliary generator power unit. Forming part of the main engine installation are integral heat exchangers, lubricating oil coolers, various pumps and strainers, clutch coupled bilge pumps, &c. Auxiliaries in the machinery compartment include a Gardner 3LW diesel engine directly coupled to a 20kW, 110V, d.c. generator and clutch-coupled to a 15 tons per hour self-priming general service pump. There are also a 7½kW, 115V, d.c. generator belt-driven from the starboard main engine, motor-driven oil fuel and fresh-water transfer pumps, and salt-water sanitary pumps. Fuel tanks, through which runs a pipe passage, are arranged to port and starboard forward of the engine-room and carry enough bunkers to give the yacht a cruising range of over 3000 nautical miles.

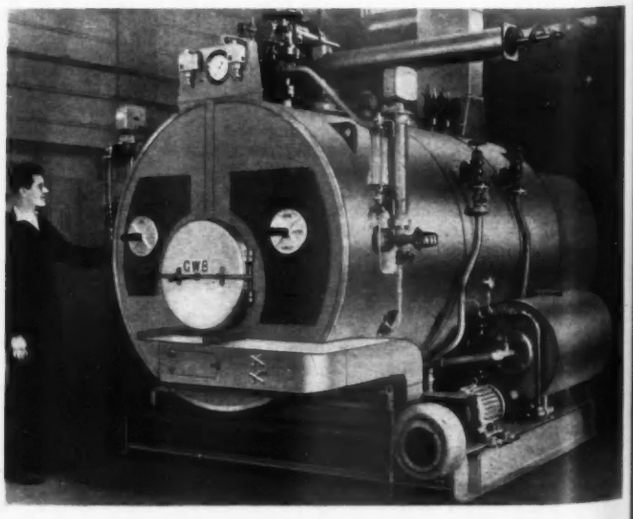
Solid Fuel Fired Packaged Boiler

A NEW packaged boiler, the G.W.B. "Vekos-Powermaster" is now being marketed by the Boiler Division of G.W.B. Furnaces, Ltd., and has been specifically designed for solid fuel firing while incorporating the advantages of economical and efficient operation inherent in the design of "Powermaster" oil- or gas-fired boilers. As for other packaged units it is compact, self-contained and is delivered complete, and furthermore is easily installed and requires no special foundations. It is also claimed by the manufacturers that this boiler gives a constant efficiency of more than 80 per cent when burning a wide variety of fuels and without the use of economisers or superheaters. In achieving this efficiency the fuels burnt have been strongly caking, free burning, low ash content and high ash types, and the size of fuel has ranged from small coal to singles. To conform with the requirements of the Clean Air Act and also the F.B.I. recommendation that the flue dust pollution should not exceed 0·2 grains per cubic foot, the boiler has built-in multi-cell grit arresters.

Control is by steam pressure or water temperature within the firing range of 30 to 100 per cent of load, and at all settings the fuel and air is maintained at the correct ratio. A screw conveyor, driven by a two-speed motor controlled by pressure or temperature in the boiler, feeds the fuel through the crown of the boiler to a vortex chamber which is supplied with air from a forced draught fan, so ensuring that the fuel is evenly distributed on the firing bed. The fan provides not only tertiary air but also over-fire secondary combustion air and under-grate primary air, all controlled by a simple damper. There are no moving parts in the furnace and it is estimated that the grate, which is of V formation and has fire bars of 2 per cent chrome iron, will have a minimum life of five years. Swan neck air ports in the grate bars deliver the under-fire air to the fuel bed, and the resulting smooth and well distributed air supply to the fuel bed reduces the tendency for blow holes and eliminates riddlings through the bars. With regard to the attention required, it is stated that if the fuel used has an ash content of 3 per cent the boiler will run for ten hours without adjustment, but after this period it will be necessary to de-ash, an operation which will only drop maximum output for five minutes. Inspection of the boiler does not require the hearth to be removed and the flue can be entered through the fire door, while access doors at the rear permit the removal of any accumulated ash. In the event of a power failure provision has been made to allow the boiler to be fired by hand.

Three models, one of which we illustrate, are available at present, namely models 75, 125 and 200, having outputs, based on steam from and at 212 deg. Fah., of 2760 lb, 4300 lb, and 7000 lb per hour respectively. Later, units having outputs of 10,000 lb, 14,000 lb, and 18,000 lb per hour will be available. Although the "Vekos-Powermaster" is specifically designed for solid fuel it can be converted easily to oil or gas firing or can be supplied equipped for any combination of oil/gas/solid fuel firing.

[Reply Card No. E1129]



One of a range of solid fuel fired packaged boilers

Automatic Graph Plotters

We illustrate the control cabinet and plotting table of one of the automatic graph plotters now being manufactured in this country by Benson-Lehner (G.B.), Ltd., of West Quay Road, Southampton. These "Electroplotter" equipments were originally developed by the Benson-Lehner Corporation in Los Angeles. The Model H, illustrated, handles data from punched cards, punched tape or a keyboard. Numbers up to four digits are dealt with, and points are plotted within an area of 30in by 30in by a symbol such as a full stop or a star, and are positioned to an accuracy of a hundredth of an inch. Paper supply and take-up reels are situated along opposite edges of the horizontal table, while two bars, arranged at right angles to each other, span the table and carry the plotting head at their intersection.

Control panels and plotting table for producing graphs from punched tape or card data

One of the problems during development was how to keep the graph paper in place on the plotting machine. In the latest models the graph paper is held by vacuum against a sheet of "Vyon" ¼in thick. "Vyon" is a permeable material of medium pore size made from high-density Ziegler polyethylene and is manufactured by Porous Plastics, Ltd., Dagenham Dock, Essex. Its porosity provides even application of the vacuum over the whole paper. The "Vyon" sheets used are 31in square and form a smooth, hard plotting surface, but it is essential to use a thin, dense graph paper with a low permeability, conforming to international standards; other papers are liable to crinkle or slip out of place and as a result ruin the graph.

The "Electroplotter" Model H can plot any one of twelve symbols and lay out several different curves simultaneously. It deals with about fifty such data points per minute. The plotter can also draw straight lines between consecutive data points at the rate of about fifteen per minute, all positioned to an accuracy of one-hundredth of an inch. Stepped graphs recording variations in stock level and similar administrative control data can also be prepared quickly.

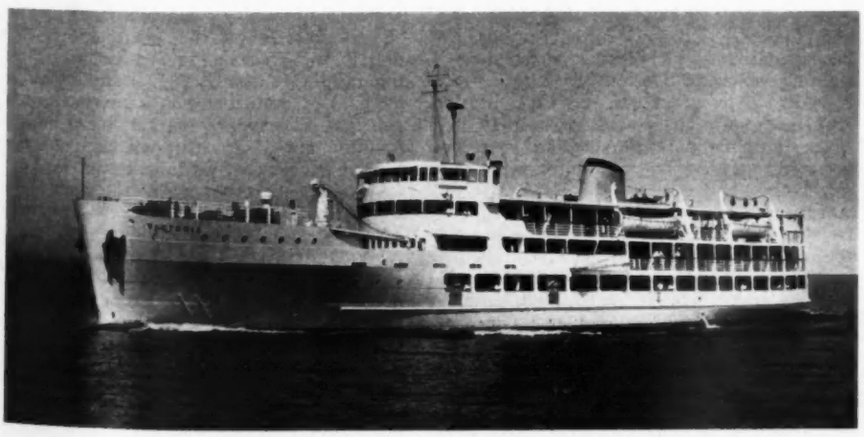
[Reply Card No. 1114]

R.M.S. "Victoria"

Since the war the East African Railways and Harbours has been expanding its fleet to meet the demands for increased transport facilities on Lake Victoria, a total of 242,000 tons of goods being carried last year compared with 19,000 tons in 1910. A number of small craft have been built locally, but to improve passenger services it was decided to build a new ship to the designs of the naval architects, Sir J. H. Biles and Co. The order was placed with Yarrow and Co., Ltd., and in our issue of September 4, 1959, we gave some account of the ship and included an illustration of the ship bolt assembled on the stocks. Since then the dismantled parts have been crated, shipped out to Mombasa, and then transported 600 miles by rail to Kisumu on Lake Victoria. Re-erection of the parts has been carried out at the Kisumu dockyard of the East African Railways and Harbours, and following successful trials in June, the ship was accepted from the builders. On July 22 the ship was officially named R.M.S. "Victoria" by Lady Renison, the wife of the Governor of Kenya, and following her commissioning the ship sailed on an inaugural voyage to Mwanza, Port Bell and Entebbe. R.M.S. "Victoria" began her regular passenger service on August 2, sailing twice a week from Kisumu.

The ship, which is shown on trials in our illustration, has the following principal particulars: length overall 261ft; breadth moulded 40ft; depth moulded 13ft to main deck and 21ft to upper deck; draught loaded 9ft; load displacement 1500 tons; service speed 13¼ knots and range 1500 miles. The service speed enables the ship to make two voyages round the lake each week and so provides the same frequency of service as that given by "Usoga" and "Rusinga" which are forty-eight years and forty-seven years old respectively. There are two complete decks, a forecastle, a boat deck, and eight watertight bulkheads which provide adequate subdivision. Accommodation on board includes eighteen two-berth cabins, a dining saloon to seat thirty-six, served by a fully equipped electric galley, and a lounge bar for the first-class passengers, and eleven six-berth cabins and a cafeteria for the second-class passengers, while for the 500 third-class passengers there are two lounges and provision for obtaining meals. Promenade space, over which is a light alloy awning, is available on the boat deck, and the ship is mechanically ventilated throughout on the Thermotank system. Officers' cabins are on the boat deck below the bridge, and the remainder of the crew are quartered in cabins on the main deck. Some 5000 cubic feet of refrigerated cargo can be carried at temperatures down to −5 deg. Fah., and there is hold space for twelve motor vehicles. The hold is served by a 3-ton electric crane.

For propulsion purposes there are installed two Crossley Mark H.R. vee two-stroke, reversible, exhaust pulse pressurised, direct-injection diesel engines, each having ten cylinders of 10·5in bore by 13·5in stroke and developing 850 b.h.p. Electric power required for engine-room auxiliaries and ship's services is provided by two 125kW, 220V, d.c. diesel-driven generators, and steering is effected by two spade semi-balanced rudders operated by Vickers-Armstrongs hand and power electric hydraulic steering gear.



Passenger and cargo vessel R.M.S. "Victoria" for East African Railways and Harbours

Launches and Trial Trips

Clan Macnab, cargo liner; built by The Greenock Dockyard Company, Ltd., for the Clan Line; length between perpendiculars 468ft, breadth moulded 61ft 6in, depth moulded to upper deck 38ft, deadweight 10,600 tons on 26ft 7¼in mean draught, gross tonnage 9428, service speed 15¾ knots; five cargo holds of 596,250 cubic feet bale capacity; one 80-ton, one 40-ton, four 15-ton, two 10-ton and ten 5-ton derricks, sixteen electric winches; three 185kW diesel-driven generators; Wallsend-Doxford oil engine, six cylinders of 670mm bore by 2320mm combined stroke, 6000 b.h.p. at 112 r.p.m. Trial, May 4 and 5.

Marietta, general cargo ship; built by The Burntisland Shipbuilding Company, Ltd., for Panultra S.A., Panama; length between perpendiculars 450ft, breadth moulded 62ft, depth moulded to upper deck 38ft 9in, load draught 29ft 2in, deadweight 13,000 tons, service speed 15 knots; five holds, two 25-ton, three 10-ton, nine 5-ton, and two 3-ton derricks; three 200kW generators; Gotaverken single-acting, two-stroke, diesel engine of 760mm bore by 1500mm stroke, 6300 b.h.p. at 112 r.p.m. Trial, May 31.

Toro, coastal tanker; built by Henry Robb, Ltd., for Union Lighterage Company, Ltd.; length overall 171ft 5in, breadth moulded 33ft, depth moulded 10ft 6in, draught loaded 9ft 3in, cargo 690 tons of heavy oil in bulk; two diesel-driven auxiliary generating and pumping sets, two Stothert and Pitt 178 tons per hour cargo oil pumps, one 10kW diesel-driven auxiliary generator and compressor; Deutz single-acting, four-stroke diesel engine, 660 b.h.p. Launch, June 1.

Tindfonn, oil tanker; built at Belfast by Harland and Wolff, Ltd., for Skibsaktieselskapet Dalfonn, Stavanger, Norway; length between perpendiculars 715ft, breadth moulded 98ft, depth moulded 52ft 6in, deadweight 47,100 tons; air-conditioned accommodation; twelve sets of cargo oil compartments and one main cargo pumproom; two 500kW turbine-driven Allen alternators, one 100kW diesel-driven alternator; one set of double reduction geared turbines, 16,000 service s.h.p.; steam supplied at 600 lb per square inch and 900 deg. Fah. by two Babcock and Wilcox boilers. Trial, June 1.

INDUSTRIAL NEWS

Prices, Productivity and Income

The fourth report of the Council on Prices, Productivity and Incomes, which was published earlier this week, suggests that Britain has not done as well as it might. The standard of living has gone up, it states, but it could and should have gone up more. Two weaknesses that have held it back appear by contrast with other countries, the Council says; production has not risen enough and exports have not risen enough, both weaknesses having had a common cause in inflation, that is, in the persistent tendency of pay and profits to rise faster than production. Inflation has weakened the forces that normally make for increased efficiency, and by making the home market easy to sell in and by raising costs it has weakened the will and ability to export. Over the next ten years investment and technical progress should make it possible to raise the standard of living by as much as a third, the Council suggests, but Britain will not do as well as this, it warns, if inflation goes on.

In its comments on the need for raising productivity, the Council points out that the shortages of skilled workers call attention to the lack of estimates of the prospective demand for particular kinds of labour. Such estimates would be possible only if employers of labour in units of more than a certain size were called upon to report their foreseeable requirements over, say, the next three years. When put together, these reports would provide a projection of requirements in the national aggregate or for certain sectors. Such projections, the Council believes, would throw up the probability of particular shortages, and very likely of some redundancies too. The projections would guide the development of technical training and give it an increased sense of purpose. They might also reveal need for retraining and resettlement programmes, the Council says, and be a more solid basis for the discussion of apprenticeship schemes and quotas. The Council also believes that increased attention to training in the specific skills appropriate to supervision and management will exert a deep and pervasive influence on productivity.

Turning to investment, the Council stresses that effective investment needs to be programmed. Hitherto, it adds, it is investment that has had to bear the greater part of the cutting back when restraints are imposed. But it is useless to enunciate the principle that investment programmes should be left undisturbed, the Council goes on to say, unless ways can be found of promptly checking expenditure on consumption. The new proposal that would enable the rate of indirect taxation to be varied during the interval between Budgets, it adds, therefore marks a notable advance.

The report emphasises that it is essential to avoid excess demand, and adds that measures to adjust the rise of demand need to be supplemented by policy that bears more directly on decisions about rates of pay and profit.

A money income policy must deal with both profits and pay, the Council says. No one rate of profit can be fixed upon as adequate to fulfil the functions of profits in all circumstances, and public policy cannot simply aim at preventing or recapturing profits in excess of a norm. What a general policy can do is rather to provide as far as possible that profits can be made only in fields that are open to buyers and sellers generally and not sheltered or restricted; that costs have to stand the test of competition; and that profitability is the mark only of efficiency in meeting demand. Two ways in which such a policy can be brought to bear, the Council suggests, are to take action against agreements for price maintenance and to reduce import duties.

In considering policy towards the rise of wages and salaries, the Council says that the need is not to stop the rise, but to see that it does not exceed the rise in productivity. One suggestion, the Council states, is to have a projection, for a period ahead, of the extent to which productivity in the national aggregate may be expected to advance. This projection would cover the production of goods and services of all kinds by the whole working population, and not the industrial sector alone. Such a projection could be related to a planned investment programme, and to forward assessments of manpower needs and resources. It could be an indicator of the anticipated pace of growth of the whole economy, and would be a guide for those responsible in their own particular fields for the planning of production, the fixing of prices and profit margins, and the settlement of wages and salaries.

Industrial Training

The second report of the Industrial Training Council, January, 1960, to March, 1961, published earlier this week, describes the work carried out by the I.T.C. during this period, which was mainly concerned with the steps taken to encourage industry, through employers' organisations and trade unions, to take full advantage of the "bulge" in school leavers by recruiting and training more skilled workers. The Council stresses that action taken by the individual industrial organisations is of vital importance, and the report includes an account of what has been done during 1960 by the organisations in thirty-six industries.

While the development of training arrangements is necessarily a slow process, the report states, the Council is far from satisfied that all industrial organisations are taking their responsibilities in the matter of training sufficiently seriously. The Council considers that each employers' organisation and trade union has a vital role to play, and urges those organisations which have not yet made progress to re-examine what they might usefully do to help the companies and workpeople in their industries.

The Council's training advisory service was set up in February, 1960, to offer practical assistance with training to employers' organisations, joint councils and, through such bodies, to individual companies. The main work of its officers during the period under review has been to make the service known as widely as possible and to find out the types of service most needed. Personal contact was established with employers' organisations or joint councils in sixty-three industries with the objects of explaining what the service could do and of inviting its use in cases where it appeared that its advice and assistance could be of benefit.

Attitudes Towards Exporting

A pilot study was carried out in March, 1961, by Marplan, Ltd., on behalf of the "Export Action Now" Committee of the Institute of Directors, to discover just what were the factors inhibiting the expansion of export business, and which of them were the most important. A report published this week by the Institute of Directors contains the results of this inquiry. Interviews were carried out with fifty-two medium, small and very small firms, divided between London, Sheffield, Leicester, Manchester, Birmingham and Newcastle. In nearly all cases the person interviewed was the managing director of the firm concerned. The study was confined to firms having not more than 300 employees, since the problems in the export field of the giant enterprise, the Institute says, are quite different from those facing the majority of British manufacturers. The firms were chosen to cover as wide a range of products as possible, half of them being manufacturers of consumer goods, and the other half of engineering products.

The firms which were interviewed fell into four main groups. About 25 per cent were exporting between 20 and 25 per cent of their total production. The second group, which accounted for about half of the total of firms interviewed, consisted of firms whose volume of exports was either declining or else static at a not very high level. Group three comprised those firms who said they felt they would like to get into the export field, but did not know how to set about it: this group was a small one. The last group, accounting for slightly less than 25 per cent of all firms interviewed, covered those firms which did not export at all, had never exported, or were not really very interested in exporting. The Institute points out, however, that this analysis, which might at first sight seem rather alarming, is not really quite as bad as it appears: the medium-sized firms, 100 to 300 employees, showed a much more reassuring pattern than the small, forty to ninety-nine employees, or the very small, under forty employees.

One major finding which emerged beyond all possible doubt, the Institute says, was that in the overwhelming majority of cases, the failure of the British manufacturer to increase or even maintain his exports, or to get into the export market at all, was a function not of any external circumstances, but of his general attitude toward exports. It was not that he could not export, but simply that he did not want to. There were, of course, the Institute adds, a wide variety of different reasons why a particular manufacturer should not be especially anxious to devote much attention to exports, and these are discussed in detail in the report. They range, from, on the one hand, serious assessments the relative profitability of expansion in the home as against the export markets, to, on the other, a complete lack of interest in anything which might be troublesome or involve more work.

PERSONAL AND BUSINESS

Appointments

MR. F. W. STOKES has been appointed managing director of Powell Duffryn Carbon Products, Ltd.

THE DOWTY GROUP announces that Sir Miles Thomas has accepted an invitation to join its board.

MR. COLIN NORTON-SMITH has been appointed public relations officer to the Locomotive and Allied Manufacturers' Association of Great Britain.

ROLLS-ROYCE, Ltd., announces that Mr. T. P. Barlow, works manager of the oil engine division, has been appointed a director of the division.

MR. PETER SMEDLEY has been appointed by British Resin Products, Ltd. as press officer for "Rockite" moulding materials and "Cellobond" and "Epok" resins.

LONDON MIDLAND REGION, BRITISH RAILWAYS, announces the appointment of Mr. M. B. C. Johns, A.M.I.C.E., A.M.I.Struct.E. as district engineer, Derby (South).

MR. G. C. S. GREENHEAD, F.C.I.S., M.B.I.M., who joined Parkinson Cowan, Ltd. two years ago as general manager (administration), has now been appointed to the board of directors.

MR. BERNARD FELTBOWER, who joined The English Electric Company at the beginning of July, has been appointed chief engineer of the company's control gear division at Kidsgrove, Stoke-on-Trent.

THE SUPERHEATER COMPANY, Ltd., has announced that Mr. J. V. Santry has resigned his directorship, and Mr. J. Mayer, of International Combustion (Holdings), Ltd., has been appointed a director.

J. I. CASE COMPANY, Ltd., announces that Mr. T. D. A. Caunt has joined the company in the position of northern area sales manager. He will be based at the newly-opened sales office at Stanningley, Leeds.

BRITISH INSULATED CALLENDER'S CABLES, Ltd. announces the appointment of Mr. J. Large, winding wires divisional manager, as general manager, winding wires division, with effect from August 1, 1961.

LONDON TRANSPORT announces that Mr. H. E. Styles, F.R.I.C., has been appointed director of research with effect from July 31, 1961, in succession to Mr. A. T. Wilford, who has retired. Mr. A. G. Collings, F.R.I.C., has been appointed assistant director of research, from the same date.

DR. B. L. GOODLETT, M.I.Mech.E., M.I.E.E., is retiring from his position as managing director of Brush Electrical Engineering Company, Ltd., Loughborough, due to ill health. He will continue in a less arduous post as vice-chairman. Mr. J. E. Smith, M.I.Mar.E., at present managing director of The National Gas and Oil Engine Company, Ltd., will assume the position of managing director of Brush Electrical Engineering Company, Ltd.

Business Announcements

W. G. PYE AND CO., Ltd., Granta Works, York Street, Cambridge, states that its new telephone number is Cambridge 58866.

C. A. PARSONS AND CO., Ltd., announces that its London office is now in new premises at 40, Broadway, Westminster, London, S.W.1 (telephone Whitehall 3984).

TROJAN, Ltd., has acquired the world manufacturing and sales rights of the Heinkel three-wheeler, which will henceforth be known as the Trojan car. This arrangement does not affect the Heinkel scooter.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces that a new warehouse has been opened in Haverton Hill Road, Stockton-on-Tees. This is subsidiary to the main stores and offices of B.I.C.C. Middlesbrough Branch in Norton Street, Middlesbrough.

SIR JOHN BENSTEAD, M.Inst.T., deputy chairman of The British Transport Commission, is retiring on September 30 next on completion of his present term of office. Sir John has been a full-time member of the Commission since September, 1947, and deputy chairman since 1949.

THE HAWKER SIDDELEY Group states that the facilities of the Group's two heavy diesel factories, Mirrlees, Bicketon and Day, Ltd., and The National Gas and Oil Engine Company, Ltd., both of which are located in the Manchester area, are being combined into one organisation which will be Britain's largest manufacturer of medium speed diesel engines. Chairman of the new company will be Sir George Briggs, and Mr. C. F. Barnard will be vice-chairman and managing director.

W. C. HOLMES AND CO., Ltd., state that the Chemical Engineering Division of the company has obtained a licence from the International Engineering and Trading Society N.V. of Holland to market the "Kathabar" humidity conditioning system in the United Kingdom.

THE SOCIETY OF CHEMICAL INDUSTRY announces the formation of a new subject group, to be known as the "Industrial Water and Effluents" group, under the chairmanship of Dr. B. A. Southgate. The first meeting will take place on November 1 at the Royal Institution, 21, Albemarle Street, London, W.1.

ICOS (GREAT BRITAIN), Ltd., a new company, has has been formed in this country from the parent Italian company, to make available here the I.C.O.S. (Impresa Costruzioni Opere Specializzate) process in its various forms on constructional sites. The process depends on the use of bentonite slurry to stabilise an excavated trench, and is thus used in such applications as to replace steel sheet-piling or to construct the cut-off below a dam. The first use of the process in this country, at the Hyde Park Corner road improvement scheme, was described in THE ENGINEER of October 28 last, page 698.

JOY-SULLIVAN, Ltd., has announced that a new division has been formed to handle the design, construction and installation of electrical and mechanical precipitators. This move is the result of the merging, in 1959, of Western Precipitation Corporation of Los Angeles with Joy Manufacturing Company of Pittsburgh, parent company of Joy-Sullivan, Ltd. General manager of the new division is Mr. Kenneth H. Cree. A sales office for Western Precipitation Division of Joy-Sullivan, Ltd. has been established at 7, Harley Street, London, W.1 (telephone, Langham 7711), and design and construction will be carried out at Greenock, Scotland, under Mr. A. E. Tolhurst.

BRITISH BROWN-BOVERI, Ltd., 75, Victoria Street, London, S.W.1, states that the licence agreement between Brown Boveri and Richardsons Westgarth, covering the manufacture and sale in the United Kingdom of steam and gas turbines, turbo alternators, blowers and compressors to Brown Boveri design has been terminated by mutual agreement. The termination became effective on April 1, 1961. Both parties will continue to collaborate for the completion of current contracts as well as for the servicing of existing machines. As from April 1, 1961, all thermal equipment as already described will be offered solely by British Brown Boveri, Ltd., and manufactured by Brown Boveri.

ALFRED HERBERT, Ltd., announce that Mr. B. C. Harrison, M.I.Mech.E., M.I.P.E., has been elected deputy managing director of the company. Mr. Harrison, who was apprenticed to the company in 1924, and was appointed factory planning manager in 1940, was elected to the board of the company in February, 1947, as works director, and in 1955 became director of design. Mr. J. W. Ellson, after forty-two years service with the company has, at his own request, retired from the board. At the request of the chairman of the company, Colonel C. W. Clark, Mr. Ellson has agreed to undertake lighter duties so that his experience will still be available to the company. Mr. A. E. Smith, F.C.A., has been appointed to the board of Alfred Herbert as deputy financial director. Mr. S. A. B. Muirhead, works director, has had his duties extended to cover production in the company's main subsidiaries at Birmingham, Leicester, Harlow and Letchworth.

Contracts

HEENAN AND FROUDE, Ltd., has contracted to supply to Cantieri Navali Riuniti, Genoa, a Froude hydraulic dynamometer capable of testing marine engines of up to 30,000 b.h.p. at speeds between 100 and 225 r.p.m.

PYE TELECOMMUNICATIONS, Ltd., has received a contract from the British Broadcasting Corporation for the supply of four microwave links for conveying programmes to low-power "gap filling" television stations. The links will operate in the 7000 Mc/s band and each will consist of a transmitting terminal, with two transmitters, and a receiving terminal, with two receivers. Automatic changeover facilities will be provided. The company is supplying also to the B.B.C. a duplicated microwave transmitting terminal for installation at the Corporation's North Hessary Tor station.

WILLIAM BOBY AND CO., has been awarded contracts by British Glues and Chemicals, Ltd., for the supply of two de-alkalisation-base exchange plants. The total value of the orders is more than £10,000. The plants will be installed at the Luton and Bermondsey works, and will have capacities of 3000 and 4000 gallons per hour respectively.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., has been awarded a £1,000,000 contract from the Indian Railway Board for the supply and installation of overhead equipment for 25kV, 50 c/s a.c. railway electrification on 250 track-miles of suburban line in the Calcutta area. The sections concerned are from Sealdah to Ranaghat, and over the branch from Dum Dum to Bonagon. This is the third contract received by the company in connection with a.c. electrification in India, the three together covering some 1000 track-miles and having a combined value in the region of £4,700,000.

W. H. ALLEN, SONS AND CO., Ltd., Bedford, have received from Peter Dixon and Son, Ltd., an order for a 6450kW back-pressure turbo-alternator set, to be installed in the power station of the West Marsh Paper Mills, Grimsby. The set is designed for steam at 415 lb per square inch gauge and 700 deg. Fah., exhausting up to 110,000 lb per hour of steam to process at 10 lb per square inch gauge. The turbine will drive a 3·3kV, 50 c/s, 0·8 power factor, duct-ventilated Mather and Platt alternator, the turbine speed of 7000 r.p.m. being reduced to the alternator speed of 1500 r.p.m. by Allen-Stoeckicht epicyclic gearing. Besides supplying alternating current the set will supplement, through a rectifier, the direct current supply from an existing 3000kW Allen d.c. turbo-generator. The alternator cooling air will be available for space heating.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., has received orders for two new C.E.G.B. outdoor switching stations. One, at Lovedean (near Portsmouth), will be a transforming point on a supergrid line associated with the 550MW nuclear power station being built at Dungeness. This order, worth £800,000, is for nineteen air-blast circuit breakers (three rated at 275kV, 15,000MVA and sixteen at 132kV, 3500MVA) and the associated isolators and control equipment. The three 275kV breakers will be fitted with high-speed auto-reclosing mechanisms, and the 132kV equipment will comprise four transformer circuit breakers, two bus-couplers, one bus-section and nine feeders. The second order, worth £400,000, for a C.E.G.B. switching station in Gloucester (consulting engineers, Kennedy and Donkin) includes three 275kV, 15,000MVA air-blast circuit breakers; ultimately the layout will be a four-switch box-mesh station. The order also includes two 132kV, 3500MVA air-blast circuit breakers with isolators and control gear for connection to the existing 132kV substation at Port Ham.

Awards

THE INSTITUTION OF CHEMICAL ENGINEERS announces that in accordance with the terms of the C.J.B. Scholarship scheme administered jointly by The Institution of Chemical Engineers and Constructors John Brown, Ltd., a research scholarship has been awarded to Mr. A. C. Evans of the Department of Chemical Engineering, University of Leeds, to the value of £450 per annum, for two years in the first instance. The purpose of the Scholarship is to encourage research in chemical engineering and, in particular, in chemical plant design.

Death

WE regret to record the death of Mr. E. L. Pipe, which occurred recently at the age of fifty. Mr. Pipe joined F. W. Berk and Co., Ltd., in January, 1937, and, following active service overseas during the war, represented the company in the foundry industry. He was well known in foundry circles, particularly in the Midlands, South Wales and the West country.

WE record with regret the death of Mr. J. H. Caramel, M.I.H.V.E., chairman and managing director of Norris Warming (Holdings), Ltd. He died in London on July 25 at the age of sixty-one. Mr. Caramel joined the House of Norris in 1916. Became a director in 1927 and was appointed managing director of Norris Warming Company, Ltd., and F. A. Norris and Co., Ltd., in 1938. On the the formation of Norris Warming (Holdings), Ltd., in 1955, he was elected chairman and managing director. Mr. Caramel was Past-President of the Association of Heating, Ventilating and Domestic Engineering Employers and was a Liveryman of the Worshipful Company of Plumbers.

THE UPPER ISÈRE AND ARC: COMPREHENSIVE WATER POWER DEVELOPMENTS

PRINCIPAL STORAGE RESERVOIRS.

	CAPACITY CUBIC METRES × 10^6	TOP WATER LEVEL METRES A.S.L.	CATCHMENT AREA SQ. KILOMETRES
TIGNES	235	1790	203
ROSELEND (INCLUDING ST. GUÉRIN AND LA GITTAZ)	240	1557	257
MONT CENIS (PROPOSED) *	321	1974	295
CHAMPAGNY (PROPOSED)	200 TO 250	ABOUT 1650	—
LA GIROTTE	50	1753	34
LA BISSORTE	40	ABOUT 2000	48

* 270 AVAILABLE FOR FRANCE, 51 FOR ITALY.

PRINCIPAL POWER STATIONS.

	INSTALLED CAPACITY MW	GROSS HEAD METRES	AVERAGE ANNUAL OUTPUT GWh
ON THE ISÈRE, DOWNSTREAM FROM TIGNES RESERVOIR:—			
LES BREVIÈRES	93	233/93	180
MALGOVERT	320	750	800
MOUTIERS	160	334	500
RANDENS (ISÈRE - ARC)	140	153	450
ROSELEND SCHEME: LA BATHIE.	500	1209	1000
MAJOR PROJECTS ON THE ARC:—			
MONT CENIS (PROPOSED)	350	882	577
MIDDLE ARC (PROPOSED)	—	540	500
LOWER ARC (ARC - ISÈRE) (PROPOSED)	—	285	787
GRAND' MAISON - FROGES PROJECT (PROPOSED)	1000	1400	—
AUSSOIS (ARC)	100	860	350
BISSORTE (ARC)	87	1145	175
PRALOGNAN (DORON)	51	725	170
BEAUFORTIN CHAIN	83	—	200

NOTE:- OTHER POWER STATIONS SHOWN ON THE MAP ARE OLDER OR LESS IMPORTANT STATIONS, IN SOME CASES PARTLY OR ENTIRELY SUPERCEDED BY THE ONES LISTED ABOVE. NOT ALL THE MINOR POWER STATIONS ARE SHOWN.

CONTINENTAL AFFAIRS

by Our Continental Editor

French Water Power: Some Recent Developments

Some recent achievements of the French hydro-electric industry are discussed. Expansion continues at a fast rate, and much importance is given to establishing seasonal storage reservoirs. Development plans for the upper Isère catchment are explained, and we briefly describe the Serre Ponçon dam and the developments associated with it on the Durance river.

HYDRO-ELECTRIC power in France is generated in quantities sufficient to supply about half the national demand for electricity. It follows that, with the rapidly increasing rates of consumption of power common to all the countries of Western Europe, much effort—financial and engineering—has been expended on developing hydro-electric sites in France in recent years, and indeed some of the more prominent feats of French engineering have been achieved in this field during the periods of the two big post-war programmes. As regards the scale of the French effort, the statistics in Table 1, give the leading data. As regards the engineering aspects and the prospects for the future, some further comment is worthwhile, since an interesting stage has now been reached.

TABLE I—*French Electricity Statistics*

Note: GW=gigawatt=10^9 watt, e.g. 1GWh=10^9kWh.

National electricity consumption :	
1950	33,400GWh
1959	64,545GWh
1960	72,000GWh
1965 (estimate)	107,000GWh
Installed capacities as at January 1, 1960, and output for the year 1959, nationally and for Electricité de France :	
National installed capacities :	
Thermal-electric (maximum possible 15 hour capacity)	9,806MW
Hydro-electric	9,053MW
National output :	
Hydro-electric	32,767GWh
Thermal-electric	31,924GWh
Consumption by pumping	−184GWh
International exchange (balance)	38GWh
Electricité de France's installed capacities :	
Thermal electric	6,042MW
Hydro-electric	7,700MW
Electricité de France's output :	
Thermal electric	15,031GWh
Hydro electric	24,779GWh
Statistics for Electricité de France for the year 1960 :	
Cost of capital programme	2,531×10^6 N.F.
Plant brought into service :	
Hydro-electric	282MW (1,500 GWh output)
Thermal-electric	495MW
Nuclear	25MW
New plant started during the year :	
Hydro-electric	1,768GWh
Thermal electric	895MW
Nuclear	120MW
Total programme under construction during the year :	
Hydro-electric	5,300GWh
Thermal-electric and nuclear	3,325MW

The principal organisation involved is, of course, Eléctricité de France, whose activities are remarkable for the high rate of capital investment maintained; the equivalent of 60 per cent of that concern's annual turnover is invested, an amount about equal to 1 per cent of the national income, which makes Eléctricité de France the largest single investor in the country. Of the various interests such as industry and railways which contribute to the national total of electricity generation there is one of special interest in the hydro-electric field, namely the Compagnie Nationale du Rhône.

Although this article surveys only hydro-electric power, it should not be thought that Eléctricité de France is not active in the complementary thermo-electric fields. Indeed the progress made here is a keen spur to the reduction of hydro-electric costs. Thermal-electric installations have been concentrated in 125MW sets, of which nine were brought into use in 1959; and three (plus two 60MW sets) in 1960. At the beginning of this year six 125MW sets were under construction, and seven sets of a new standard type, each of 250MW were also being built.

It is convenient to divide potential hydro-electric sites into low-head sites on the one hand, and the medium- and high-head sites of the mountain areas on the other. There are many sites for low-head generation still untouched on the rivers of France, and it is likely that they will receive increasing attention in the future. In general terms, these sites entail expensive civil engineering works, and result only in run-of-river power. The problem then, is to reduce the civil engineering costs, and to construct complementary schemes with ample storage in the mountain regions. Tidal power is also one of the possibilities in the low head classification; one approach to this problem was explained in some detail in the two articles "French Bulb Sets for Tidal and Low Head Power" published in this journal in our issues of January 27 and February 3 last. It may well be that a number of low head sites of small or moderate power potentialities may be developed in the next few years, in which "bulb" sets like the prototype at Beaumont-Monteux may be used, or the similar "pier-type" sets.

The two great rivers the Rhine and the Rhône offer the most ambitious prospects for power generation in the low-head range. Active programmes of construction have been in progress on both rivers for the past decade or so. On the Rhine, the Vogelgrun power station (4×35MW capacity and an annual output of 720GWh) was brought into use in 1959. This is the fourth installation on the Grand Canal d'Alsace, and was described in THE ENGINEER of August 13, 1957, page 322. With its completion the Rhine is now yielding to Eléctricité de France about 3500GWh annually, from an installed capacity of 553MW. Eventually, eight installations on the Grand Canal d'Alsace will yield 7000GWh, it is envisaged. The stage below Vogelgrun, the Marckolsheim scheme, was opened to navigation on December 16 last, but power had not been generated at that time, though this year the Marckolsheim scheme will start to contribute to the power generated from the Rhine.

The Rhône power stations are potentially greater in numbers and output than those of the Grand Canal d'Alsace; a chain of three canals and power stations is at present in service on the lower Rhône, and a fourth stage is under construction. It is our intention to describe these developments in a separate article.

MEDIUM AND HIGH HEAD SCHEMES

Apart from the power generated from the Rhine and the Rhône, the great bulk of her water power comes from the three mountain regions of France, the Alps, the Massif Central, and the Pyrenees. New schemes have been built so fast in the post-war period that exploitation of the two last named is now substantially complete. Eléctricité de France's new schemes are conceived by departmental organisations termed "Régions d'Equipement." The Région d'Equipement Hydraulique Pyrenees has been discontinued, having completed its task, though we understand it continues to exist in a different region and under a different title, and is now designing the power stations on the middle Durance. The Région d'Equipement Hydraulique Garonne remains active however, and is completing a few moderate-sized schemes in the Southern Pyrenees region.

In 1959 the Grandval dam—a multiple arch structure impounding the Truyère river in the Massif Central, which we illustrate at the time its construction was nearly finished—was completed, together with its power station of 32·5MW capacity; this dam is of especial interest since it achieves greater structural economy than hitherto, by utilising the same principle as we will describe next week for the great arch of Roselend dam. In the same region, the Golinhac scheme on the river Lot was completed last year. Each of these two schemes has an annual yield of about 140GWh. Nevertheless the Massif Central, although substantially more important than the Pyrenees in terms of its output of power, has no major sites left undeveloped, and it is to the more rugged regions of the Alps that Eléctricité de France must now turn for major developments.

Two river catchments in the Alps are of special interest, namely the Durance and the Isère. Exploitation of the Durance is briefly described in the concluding section of this article, but first attention must be given to the Isère catchment which is the most important source of water power in France, and is of almost unlimited interest to the hydro-electric engineer, equally on account of the past, present and future of his subject.

THE ISERE CATCHMENT

The accompanying map shows the principal hydro-electric developments on the upper Isère and its tributary the Arc. Two important tributaries which join the Isère at Grenoble and are not shown on the map are the rivers Drac and Romanche. A major scheme is at present under construction on the Drac at Monteynard and is due for completion in 1962–63; it will have an annual output of 430GWh, and is part of a chain of power stations forming a comprehensive programme of development on the Drac. Apart from the Monteynard scheme and its predecessor on the Drac, the St. Pierre Cognet scheme, major construction in the Isère catchment has been concentrated in the past few years on the Roselend scheme, which is now substantially complete and has at present the largest hydro-electric power station in France, and one of the most important from the point of view of peak load generation.

An extensive study of the Isère and its hydro-electric installations was published in this journal about ten years ago* which concentrated on the schemes under construction in the first major post-war programme, which was then at its height. Development has proceeded since that time very much along the general lines which were then envisaged. With the completion of the Roselend scheme it is estimated that development (as now limited by cost of construction in relation to electricity prices) of the entire catchment of the Isère is perhaps one-third of the way towards completion.

RESERVOIR SITES

There is one critical factor behind the concept of comprehensive development of a river catchment such as the Isère, namely that of seasonal storage, which must be provided by large reservoirs situated at high altitude. Aqueducts are built to divert as many streams as possible into such a reservoir, whose capacity needs to be of the same order of magnitude as the annual yield of its artificially-enlarged catchment. This

* "Hydro-electric Power in the Isère Catchment of the French Alps," THE ENGINEER, November 23 to December 28, 1951.

SERRE PONÇON DAM (ABOVE) AND GRANDVAL DAM (BELOW)

situation is, of course, imposed by the Alpine flow regime (glaciers cover some 300 square kilometres of the Isère catchment) in which most of the run-off is in late spring and summer, whereas the demand for peak load power is in the winter.

Tignes reservoir—described in our last series—has now been regulating the flow to the chain of major stations shown below it (and to others further down the Isère and on the lower Rhône) for almost a decade. Now, Roselend will add its quota of regulated flow. A third reservoir of comparable magnitude is to be built at Mont Cenis, where construction will start next year. Investigations are still in progress to determine the suitability of the proposed reservoir at Champagny. If this site proves practicable to develop at about the storage capacity listed in the legend, storage at high altitude of about 1,000 million cubic metres will have been achieved, which would be equivalent, in terms of electrical energy, to about 3000GWh in the chains of power stations below the reservoirs.

The general scheme of development could, in principle be modified at any time by the discovery of a "cuvette," (i.e. reservoir site) as favourable in capacity and altitude as well as other constructional factors, as the "cuvettes" of Tignes and Roselend. Exploration for such sites continues, therefore, If such a site is found it may be situated where international co-operation is needed to exploit it fully, as in the case of the Mont Cenis scheme. A scheme of this nature is at present being explored jointly by the French and the Swiss. Further details of the upper Isère power stations and reservoirs are listed in the legend with the map.

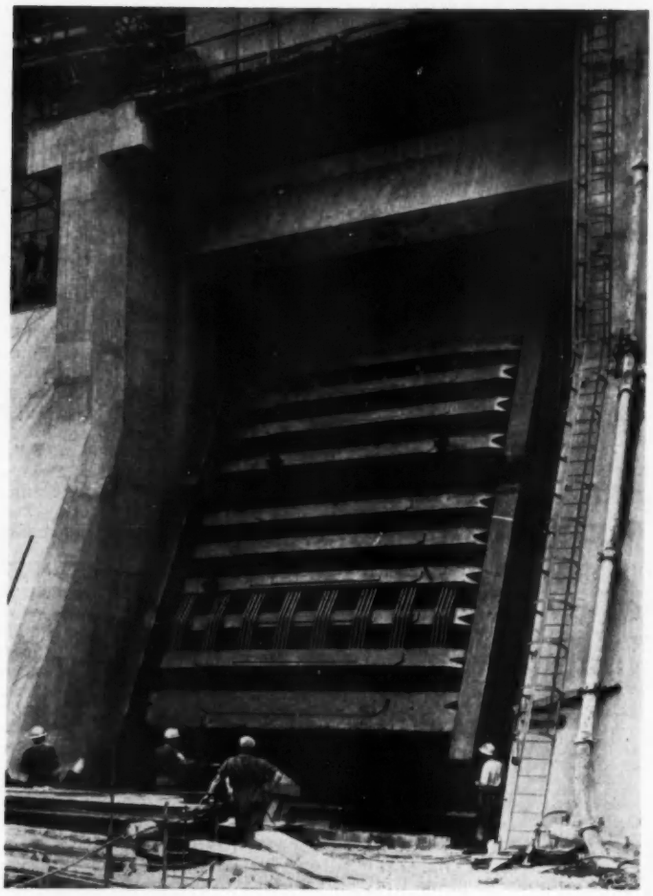
The Mont Cenis scheme, on the Arc, is at present in the design stage, the start of construction being scheduled for next year. The reservoir will be formed by a rock-fill dam about 100m in height. A pressure tunnel 18·5km long will lead from the reservoir to the power station, where four 95MW vertical-shaft Pelton wheel generating sets will be installed, operating under a maximum gross head of 882m. The penstock will be connected close to the power station with the penstock of the existing Aussois scheme, such that water from either source can be used in the power station, or the Aussois waters led back into Mont Cenis reservoir.

Although the Aussois scheme has extensive catchwater tunnels commanding 157 square kilometres (including 30 square kilometres of glaciers) its two reservoirs, called Plan d'Aval and Plan d'Amont, have together a storage capacity of only 12,000,000 cubic metres. The scheme's rated full flow for power is, however, as high as 12 cumecs (other data are given in the legend). By contrast, the Mont Cenis project will have a reservoir with a capacity somewhat greater than its mean annual inflow. The very extensive catchwater system (commanding almost 300 square kilometres) will be clear from the map. It includes a physical link with the analogous system feeding Tignes reservoir, and when the project is built it will be possible to divert the headwaters of the Arc into either Tignes or Mont Cenis reservoirs as required. The straight tunnel shown connecting Mont Cenis reservoir with the Arc, and running slightly West of North, is a scour culvert.

Other points of interest in the Mont Cenis scheme include a power station excavated out of rock, but with its roof at ground level, and the switching station on the surface above it ; a single penstock serving the power station ; a compensation pond in the Arc below the power station ; various siphons &c. in the complex of aqueducts serving the scheme. The size of the dam, however, overshadows these other aspects. It will be a rock-fill structure with an inclined core of fine material. It will have a crest length of about 1600m and a total volume of about 11,500,000 cubic metres. A reservoir of 30,000,000 cubic metres already exists at the site, serving the Italian power stations of Gran-Scala and Venaus.

The map also shows how the catchments draining to Roselend, Tignes, and Mont Cenis reservoirs link, thus providing substantially complete utilisation to the East of the two main streams from about Albertville to Modane.

It is planned that development of the Arc will proceed in three stages analogous to the three stages already existing on the upper Isère (viz. Tignes–Malgovert, Moutiers, and Isère–Arc). After completion of the Mont Cenis scheme, the Arc–Isère scheme will be built, and finally the middle Arc head will be utilised, this last stage rendering obsolete a number of existing power stations. The output figures are given in the legend. Another important project—again based on a seasonal reservoir—which is still in the stages of early deliberation is the Grand'Maison–Froges project ; here a reservoir is envisaged at 1800m altitude, with ten 100MW sets in the power station operating under a 1400m head. A scheme of this size demands a larger catchment than any of those utilised so far in the principal schemes, and it would appear from a study of the topography that this scheme could, in principle, command a part of the Romanche catchment to the south of the edge of the map. Thus the scale of individual schemes is still increasing, and much original and exacting engineering work can be expected in this region in the next decade or so.



Intake gate of Serre Ponçon scheme. The gate is 7·2m wide by 11m high (the actual gate opening being 6·2m by 11m) and withstands a maximum hydrostatic load of 9000 tonnes. The gate is a caterpillar gate weighing 135 tonnes. It can be closed against the maximum exceptional head of 126m in one minute, to cut the residual flow of 500 cumecs should it prove impossible to close either the scour valves or turbine controls. For this operation a force of 540 tonnes is applied to the gate by an oil-hydraulic device. The latter comprises a cylinder 11m long and of 0·62m diameter at crest level, with rail-guided rods 126m long and weighing 80 tonnes, connecting with the gate. The gate can be opened in thirty minutes

The Durance and Serre Ponçon Dam

The two great Alpine rivers of France are the Durance and the Isère. Both are tributaries of the Rhône, the Durance lying to the south and draining a catchment of 14,200 square kilometres, including most of the Hautes Alpes and Basses Alpes departments. The recent completion of the massive rock-fill dam of Serre Ponçon which is situated on the upper Durance near the town of Gap, has provided the key to multi-purpose utilisation of the river. The Serre Ponçon scheme is now fairly well known, and descriptions of it have been published (for instance in the *Proceedings* of the Institution of Civil Engineers Vol. 6, April, 1957). Constructional work on the scheme came to an end last year, but the top water level of the reservoir was still restricted to 760m, and plant installation in the power station continued after the other works, so the scheme comes into full operation this year. It is considered to be truly "multi-purpose" in character, since flood control and irrigation are important in the Durance valley, and are not just by-products from the generation of power. The multiple function of the scheme is one distinguishing characteristic ; another is the use of special grouting techniques to form an impervious cut-off below the dam. The present site had been considered for a dam for many years—since before the days of great demand for power, so important are its other two functions—but the existence of permeable deposits of alluvium filling a pocket 110m deep in the bottom of the valley presented an insoluble problem at a site which was otherwise exceptionally favourable. The great depth, the presence of thermal waters, complicated rock-alluvial boundaries perhaps with overhang, the permeability of the alluvial strata and the presence of large boulders in them, all rendered the construction of a cut-off by sinking caissons or open wells too hazardous. Much progress is now being made in grouting techniques, but even by to-day's standards, the success of the Serre Ponçon cut-off is quite outstanding.

The present scheme was thus preceded by an elaborate exploratory programme of trial drilling, &c. In contrast to French practice for high dams up till that time, it was decided that a rock-fill structure would be built. Removal of the alluvial pocket prior to constructing a concrete dam would have proved, if practicable, unduly costly. Originally a watertight "carpet" extending horizontally upstream from the base of the dam was envisaged, to reduce seepage under the dam to within acceptable limits. This carpet would have been about 1200m or 1500m in length (i.e. twelve times the head) and keyed into the reservoir banks over about 3km and widths of 40m or so. Such a formidable task was obviated by the construction of a vertical cut-off using bentonite and slag-cement grout. Slag cement was used because of its resistance to the aggressive ground water at the site ; up to 3 per cent of caustic soda was added as a catalyst. The "Soletanche" system of grouting was used, which depends on grouting in a controlled manner from rings of holes in a tube sunk to the required depth. The system was described in THE ENGINEER of April 5, 1957, page 532, as part of an article on the Dartford–Purfleet tunnel, where the same technique has been employed to stabilise

CONTINENTAL AFFAIRS *(Continued)*

the ground. A full account (in French) of the Serre Ponçon cut-off will be found in the paper "Réalisation par Injection d'un Ecran Impermeable en Materiau Alluvionnaire" by M. R. Maigre (Paper R79 fifth Congress on Large Dams, Paris, 1955).

Various tests, including electrical analogy methods, showed that (a) a cut-off constructed to a depth of 60m below the river bed would have reduced seepage to within safe limits (i.e. "blows" or "piping" would not occur under the dam) but the extra expense of continuing the cut-off down to the full depth necessary to key it into the rock, cost less than the capitalised value of the leaks occurring below the −60m cut-off. The complete cut-off was therefore constructed.

The dam is an enormous structure, even larger than the proposed Mont Cenis dam mentioned above. Some leading data are given in Table II. Materials for the rock and the clay core were obtained close by. The reservoir is more than twice the size of any other reservoir in France*. It has a useful capacity of 900 million cubic metres (i.e. about 730,000 acre feet).

TABLE II—*The Serre Ponçon Scheme and the Durance Power Stations*

Reservoir and hydrology :	
Catchment area above reservoir	3,600 sq. kms.
Mean altitude of catchment	2020m a.s.l.
Mean annual flow into reservoir	$2{,}700\times10^6$c.m.
Normal top water level of reservoir	780m a.s.l.
Corresponding storage capacity of reservoir :	
Total	1200×10^6c.m.
Useful	900×10^6c.m.
Rated flow through power station	300 cumecs
Surface area of reservoir	2,700 hectares
Capacity reserved for irrigation in summer drought	200×10^6c.m.
Flood storage between 780m and 788m levels	240×10^6c.m.
Road and railway construction round reservoir :	
Roads	60km
Railways	14·5km
Tunnels	Eight
Bridges	Ten
The Dam :	
Crest level of dam	788m a.s.l.
Height, stream bed to crest	120m
Crest length (developed)	600m
Width at base	600m
Width of clay core at base	55m
Volume of clay core	2×10^6c.m.
Total volume of dam	14×10^6c.m.
Rate of placing rock fill during construction :	
Maximum	27,000c.m. per day
Average	23,000c.m. per day
Consumption of grout in cut-off (dry weights) :	
Slag cement	11,000 tonnes
Colloidal clay	24,000 tonnes
Size of cut off :	
Cross section	4,200 sq. m.
Theoretical volume	100,00c.m.
Discharge capacities of :	
Scour culverts	1200 cumecs
Gated spillway at 780m water level	1,980 cumecs
Gated spillway at 782·5m water level	2,200 cumecs
The Power Station :	
Installed capacity	4×80MW
Maximum head	125m
Mean head	107m
Annual output	700GWh

	Installed Capacity MW	Mean annual output GWh
Serre Ponçon	320	700
Middle Durance schemes	800	2,800
Lower Durance schemes	510	2,300
Total	1,630	5,800

The main arm of the reservoir extends upstream for about 20km. The old village of Savines has been inundated, and a new village is being constructed. A feature of the scheme has been the extensive work of rerouting communications round the reservoir. About 60km of road and 15km of railway have been built round its banks in very rugged country, including the prestressed concrete bridge at Savines which has eleven 77m and two 38·5m spans (it was illustrated on Plate 13 of THE ENGINEER of January 13 last). The cost of building the Serre Ponçon dam and its associated works has been about 480 million N.F.; so extensive have been the communication works around the reservoir that they have cost, in addition, 120 million N.F.

The power station associated with the dam is underground, and discharges into a compensating reservoir of appreciable magnitude (6,000,000 cubic metres useful capacity) which has been constructed by building a barrage below an extensive borrow area needed to win material for the dam. The peak load discharges from Serre Ponçon power station are held in this reservoir to give an even river flow downstream.

During construction, the river was diverted through two tunnels on the left bank. These tunnels are now incorporated in the permanent works. Two penstocks branch from each of them, to the intakes of the turbines, and the tunnels also function as scour culverts, each being controlled downstream of the branches by two 2·6×5·7m caterpillar valves in series. The two tunnels are also each controlled by an intake gate; these gates are massive structures, made by the German firm of Dinglerwerke A.G., who claim that they are the largest gates of their kind in the world, and that their design "goes right to the limit of the engineering possibilities." One of the gates is illustrated on page 215, during construction, and the illustration of Serre Ponçon dam on page 214 shows the intake structure in the right background. In this illustration two concrete structures can be discerned at the reservoir bank, the farther one being the intake and the nearer one the flood spillway. The road shown on the downstream side of the dam is for construction only, and was removed on completion of the work.

The scheme was designed, and its construction supervised, by the Région d'Equipement Hydraulique Alpes II of Eléctricité de France.

* Previously Bort reservoir on the Dordogne (Massif Central) was the largest, with a capacity of 400 million cubic metres, followed by Tignes and Roselend.

THE DURANCE POWER STATIONS

The headworks for the canal of a low-head power scheme were started last year beside the Serre Ponçon compensation reservoir. This scheme—known as Curbans—will, when it is completed, thus take water directly from the compensation reservoir. In its turn, it will discharge directly into the canal of a second stage of power generation—the Sisteron scheme—the two stages extending over about 50 river kilometres. The middle Durance chain (see figures listed in Table II) will be completed by five subsequent stages of power generation, it is envisaged, extending downstream almost to the confluence of the Durance with its largest tributary, the Verdon.

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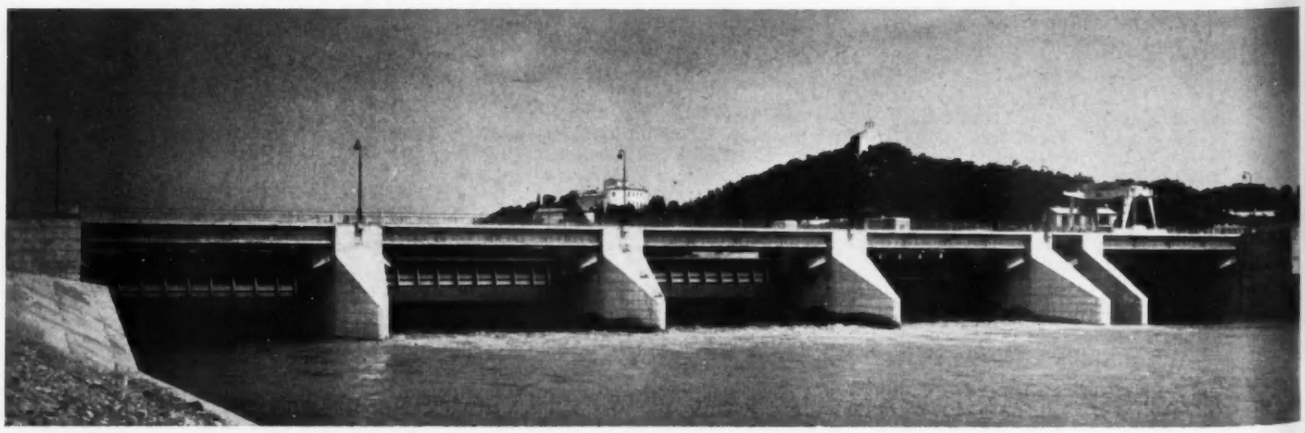

Cadarache barrage controls the Durance river just below its confluence with the Verdon. The intake for the canal feeding the Lower Durance chain of power stations is on the left bank side, and is largely obscured by the barrage in this view. The five sluices of the barrage are each 25m in length and 6·5m high

THE AMERICAN SCENE

By Our American Editor

Inspection System for Gear and Spline Tooth Spacing

A SAMPLE tooth-space checking system that also graphically helps to identify causes of tooth-spacing errors in straight or helical gears and splines has been developed by the Michigan Tool Company of Detroit, Michigan. This system provides a simple means of measuring pitch-line run-out and eliminating its effects on an index check. The inspection can be accomplished without the necessity for analysis by a highly trained man. A very short training session in the technique of the system enables the average machine operator to check toothed parts and to determine tooth-spacing errors.

The new Michigan Model 1132 Tooth Spacing and Concentricity Checker used with this system comprises a bed with ways, an adjustable pointer carriage and slide, two dial indicators and a pair of centres. The standard unit will accept shafts up to 36in long and 5in o.d. having a wide range of pitches. The unit has a quick-acting adjustable tail-stock and over-travel protection for both dial indicators. The work-piece is positively indexed through the use of an index plate, several of which for different numbers of teeth can be mounted simultaneously. A rack-type pointer tip pivots so that it contacts both flanks of a tooth near the pitch line at the time measurements are taken. The pointer unit can be swivelled so that the tip matches the helix angle of the workpiece, and pointer tips can be quickly interchanged.

The operator loads a shaft between centres on the checker and scans it with the lower indicator to locate two opposite teeth which give about the same reading. One of these two teeth is used as the starting point. In other words, the starting tooth should be on the mean of any run-out. The operator slides the pointer in to contact the first tooth and sets both indicators at zero. He records a small " x " at the origin of the graph segment, representing the first tooth. Of the three rings on the chart, the one that will give the most symmetrical pattern is used. He then withdraws the slide, indexes the shaft and moves the slide forward again. After reading both indicators, he marks a small plus sign on the graph segment for the second tooth. The radial bar of the plus sign shows the indicator reading (high or low) that measures the amount of pivot of the tip. The cross bar of the plus sign shows the indicator reading (high or low) representing slide position. This process is repeated for each tooth.

When the chart has been completed, there is an " x " in the first-tooth graph segment on the chart and a plus sign in each of the graph segments representing the rest of the teeth. The plus-sign pattern graphically describes the pitch circle of the gear or spline but, if a run-out condition exists, its centre is not on the centre of the chart and that part of the total error introduced by eccentricity cannot be visually separated from the true tooth-spacing error.

The use of a blank chart and a light table " mechanises " the separation of these errors. The blank chart is placed over the original chart in such a way that the points of origin of the graph segments representing the first tooth on both charts coincide. Then, the blank chart is pivoted about this point until the centres of the graph segments on the blank chart which represent the pitch circle of the gear without run-out coincide with the plus-sign pattern. All the plus signs for each of the teeth are traced on to the blank chart. The location of the centre of the original chart is also marked on the copy. The analysis of the gear or spline errors now is a simple matter of looking at the chart tracing. The distance between the two chart centres indicates the amount of eccentricity, or the distance of the transferred plus sign from the centre of its graph segment shows the true tooth-spacing error for each tooth since eccentricity errors have been mechanically separated out on the copied chart. A study of the chart will show what troubles, if any, exist and tell where corrective action may be necessary. The chart profile shows how the tools are working and indicates if the machine centres are causing excessive run-out.

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An experimental nuclear core designed for use in a compact reactor which would generate electricity directly without moving parts has been tested successfully by the U.S. Atomic Energy Commission. The core is only 7in high, 7in in diameter, one-fifth of a cubic foot in volume and weighs less than 200 lb. The experimental core was designed and constructed for the Commission's Office for Aircraft Reactors by Atomics International, a division of North American Aviation, Canoga Park, California, as part of a programme to develop Systems for Nuclear Auxiliary Power (SNAP) for space vehicles. The experiment is situated at a facility operated by the company in the Santa Susana Mountains 25 miles north of Los Angeles. The purpose of the experiment is to obtain physics data for the development of a complete reactor system ; no electricity is being generated. The complete system, including a thermo-electric conversion device, has been designated " SNAP 10."

The fuel and moderator in the experimental device is a homogeneous mixture of uranium 235 and zirconium hydride. The heat conduction and reflector units are made of beryllium. The device is divided into two identical units which were brought together by remote control to achieve a sustained chain reaction. Each half was built up with alternate layers of fuel-moderator disks and circular conduction plates within a reflector. In the complete " SNAP-10 " system, thermocouples will surround the reactor

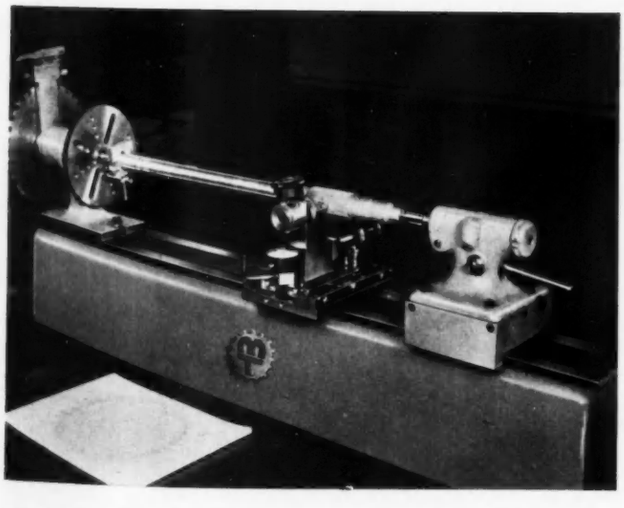

Fig. 1 (Above)—Michigan Model 1132 tooth spacing and concentricity checker

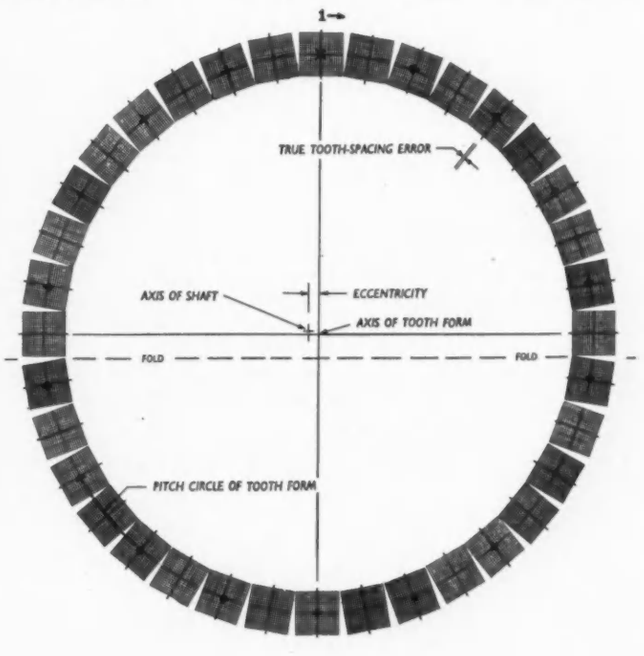

Fig. 2 (Right)—Translucent tooth spacing charts employed in conjunction with Model 1132 inspection device

CONTINENTAL AFFAIRS *(Continued)*

the ground. A full account (in French) of the Serre Ponçon cut-off will be found in the paper " Réalisation par Injection d'un Ecran Impermeable en Materiau Alluvionnaire " by M. R. Maigre (Paper R79 fifth Congress on Large Dams, Paris, 1955).

Various tests, including electrical analogy methods, showed that (a) a cut-off constructed to a depth of 60m below the river bed would have reduced seepage to within safe limits (i.e. " blows " or " piping " would not occur under the dam) but the extra expense of continuing the cut-off down to the full depth necessary to key it into the rock, cost less than the capitalised value of the leaks occurring below the —60m cut-off. The complete cut-off was therefore constructed.

The dam is an enormous structure, even larger than the proposed Mont Cenis dam mentioned above. Some leading data are given in Table II. Materials for the rock and the clay core were obtained close by. The reservoir is more than twice the size of any other reservoir in France*. It has a useful capacity of 900 million cubic metres (i.e. about 730,000 acre feet).

TABLE II—*The Serre Ponçon Scheme and the Durance Power Stations*

Reservoir and hydrology :	
Catchment area above reservoir	3,600 sq. kms.
Mean altitude of catchment	2020m a.s.l.
Mean annual flow into reservoir	$2{,}700\times10^6$c.m.
Normal top water level of reservoir	780m a.s.l.
Corresponding storage capacity of reservoir :	
Total	1200×10^6c.m.
Useful	900×10^6c.m.
Rated flow through power station	300 cumecs
Surface area of reservoir	2,700 hectares
Capacity reserved for irrigation in summer drought	200×10^6c.m.
Flood storage between 780m and 788m levels	240×10^6c.m.
Road and railway construction round reservoir :	
Roads	60km
Railways	14·5km
Tunnels	Eight
Bridges	Ten
The Dam :	
Crest level of dam	788m a.s.l.
Height, stream bed to crest	120m
Crest length (developed)	600m
Width at base	600m
Width of clay core at base	55m
Volume of clay core	2×10^6c.m.
Total volume of dam	14×10^6c.m.
Rate of placing rock fill during construction :	
Maximum	27,000c.m. per day
Average	23,000c.m. per day
Consumption of grout in cut-off (dry weights) :	
Slag cement	11,000 tonnes
Colloidal clay	24,000 tonnes
Size of cut off :	
Cross section	4,200 sq. m.
Theoretical volume	100,00c.m.
Discharge capacities of :	
Scour culverts	1200 cumecs
Gated spillway at 780m water level	1,980 cumecs
Gated spillway at 782·5m water level	2,200 cumecs
The Power Station :	
Installed capacity	4×80MW
Maximum head	125m
Mean head	107m
Annual output	700GWh

	Installed Capacity MW	Mean annual output GWh
Serre Ponçon	320	700
Middle Durance schemes	800	2,800
Lower Durance schemes	510	2,300
Total	1,630	5,800

The regulated flow made available by the reservoir is to be used for irrigation after it has passed through the various power stations envisaged on the middle and lower Durance. The 200 million cubic metres listed in the table is the proportion of useful storage reserved to ensure that irrigation water can always be supplied throughout a summer drought ; on the contrary, flood protection is catered for by the " freeboard " between normal top water level and the dam crest, the 240 million cubic metres of flood storage listed in Table II being additional to the " useful storage " figure. Model tests have verified that a flood of 6000 cumecs lasting for twenty-four hours would not entail spilling at the dam ; the worst flood known (1956) reached a peak of 1800 cumecs for several hours.

The main arm of the reservoir extends upstream for about 20km. The old village of Savines has been inundated, and a new village is being constructed. A feature of the scheme has been the extensive work of rerouting communications round the reservoir. About 60km of road and 15km of railway have been built round its banks in very rugged country, including the prestressed concrete bridge at Savines which has eleven 77m and two 38·5m spans (it was illustrated on Plate 13 of THE ENGINEER of January 13 last). The cost of building the Serre Ponçon dam and its associated works has been about 480 million N.F. ; so extensive have been the communication works around the reservoir that they have cost, in addition, 120 million N.F.

The power station associated with the dam is underground, and discharges into a compensating reservoir of appreciable magnitude (6,000,000 cubic metres useful capacity) which has been constructed by building a barrage below an extensive borrow area needed to win material for the dam. The peak load discharges from Serre Ponçon power station are held in this reservoir to give an even river flow downstream.

During construction, the river was diverted through two tunnels on the left bank. These tunnels are now incorporated in the permanent works. Two penstocks branch from each of them, to the intakes of the turbines, and the tunnels also function as scour culverts, each being controlled downstream of the branches by two $2{\cdot}6\times5{\cdot}7$m caterpillar valves in series. The two tunnels are also each controlled by an intake gate ; these gates are massive structures, made by the German firm of Dinglerwerke A.G., who claim that they are the largest gates of their kind in the world, and that their design " goes right to the limit of the engineering possibilities." One of the gates is illustrated on page 215, during construction, and the illustration of Serre Ponçon dam on page 214 shows the intake structure in the right background. In this illustration two concrete structures can be discerned at the reservoir bank, the farther one being the intake and the nearer one the flood spillway. The road shown on the downstream side of the dam is for construction only, and was removed on completion of the work.

The scheme was designed, and its construction supervised, by the Région d'Equipement Hydraulique Alpes II of Eléctricité de France.

* Previously Bort reservoir on the Dordogne (Massif Central) was the largest, with a capacity of 400 million cubic metres, followed by Tignes and Roselend.

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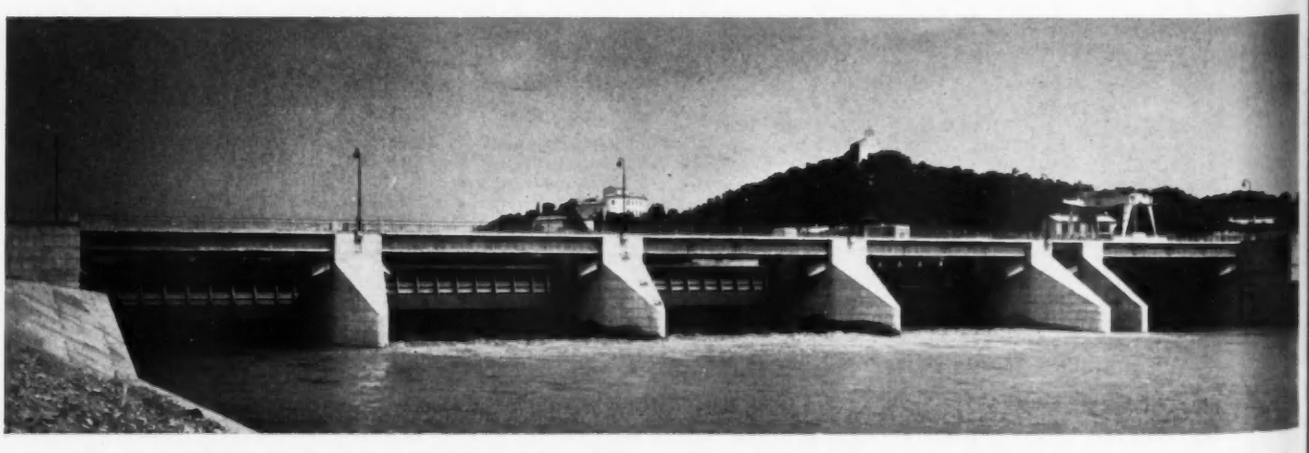

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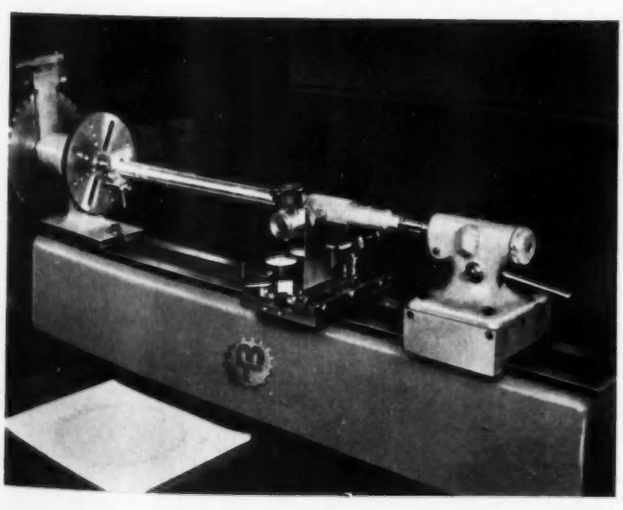

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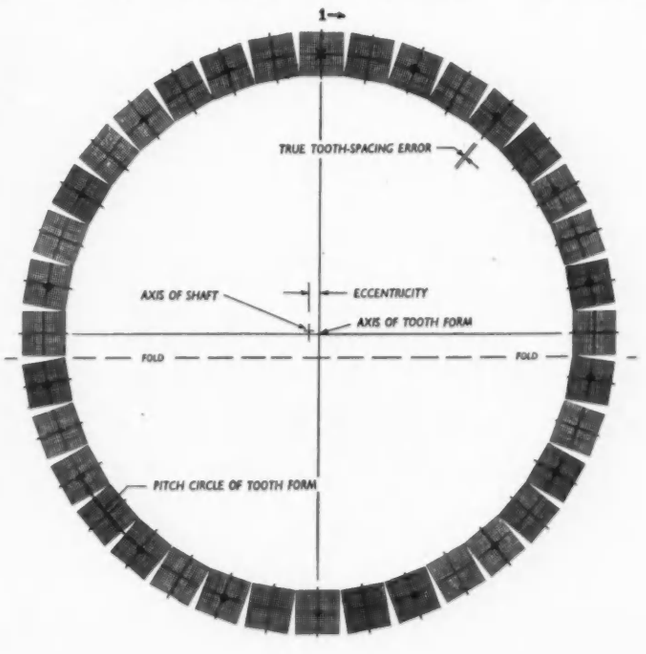


Fig. 2 (Right)—Translucent tooth spacing charts employed in conjunction with Model 1132 inspection device

THE AMERICAN SCENE *(Continued)*

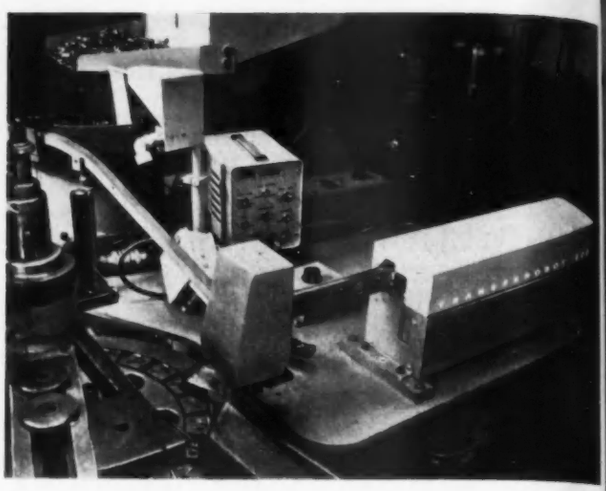
Experimental nuclear core in two halves for "SNAP 10" compact reactor

core. Electricity will be generated by the flow of heat from the reactor through the thermocouples. Excess heat, not used in the generation of the electricity, will flow through the thermocouples and then to radiator fins. The fins will radiate the heat to the atmosphere. The system for which the core is designed is expected to generate 300W of electricity.

Automatic Handling Device

The Robodyne Division of U.S. Industries, Incorporated, Silver Spring, Maryland, has introduced a low-cost industrial "robot" designed to work on an assembly line under the command of its own electronic brain. The so-called "TransfeRobot 200" device is now in production and has already been supplied to a number of large companies manufacturing such varied products as clocks, business machines, razors, and automotive and electrical equipment. The unit is believed to be the first general-purpose automation machine to be made available to manufacturers as a standard "off-the-shelf" item. All previous products in the field have been special-purpose or custom-built machines. The sales price of the new machine is 2500 dollars and the firm plans to make it available on a rental basis as well.

The Westclox Company, at La Salle, Illinois, now employs the "TransfeRobot 200" to oil a complete clock assembly as it passes on a conveyor belt. The machines oil eight precision bearings simultaneously in one second. At the Underwood Corporation in Hartford, Connecticut, the device picks up, transfers and places a small typewriter component into a close-fitting nest for an automatic machining operation. In the manufacture of an automobile steering assembly, the machine feeds partially fabricated parts to a trimming press, orders the press to cut off excess material, and ensures that the finished parts are properly discharged from the press. The versatility of the equipment in plant operation is due to the fact that it can be programmed to do many tasks merely by changing the accessories, somewhat as they are changed on a turret lathe. The machine consists of an arm and an actuator which can be fitted with many types of fingers and jaws, all under the control of a self-contained electronic brain.



"TransfeRobot 200" automatic handling device with electronic brain unit feeding typewriter components into a countersinking machine

With accessory jaws, positioning heads and feeders, and with some simple cam adjustments, the "robot" adapts with ease and low cost to a wide variety of production jobs.

The machine uses its fingers to seize, move, position and relinquish the work piece it is handling. With the use of an accessory swivel, the machine acquires a "wrist" which enables it to perform virtually any required set of motions within the limits of its reach. Upon command of its electronic brain the machine performs its own tasks and orders other machines to act as well. It is thus in constant communication with the rest of the production line. If the brain informs the device that something has gone wrong in the work programme, the machine stops and the supervisor is told, through flashing lights or buzzers, to locate and correct the error.

Rapid Jig Construction

There are now being marketed by the Special Products Sales Unit of the California Division of the Lockheed Aircraft Corporation hydraulic jig positioners able to manipulate loads of up to 2000 lb in a full six degrees of freedom. By building the jigs for the P3V–1 "Orion" anti-submarine patrol aircraft with such positioners, the California Division reduced to one-fifth the fixture-setting time. The method of working is for a piece to be placed in approximately its correct position and then clamped to the positioner. Using the positioner, two operators then align the piece in the desired position and attitude using conventional tooling telescopes; an accuracy of $\pm 0{\cdot}0002$in is available. The piece is then attached permanently to the main structure of the jig with a mixture of "Kerrstone" and water, the positioner supporting it for the eight to fifteen minutes needed for the "Kerrstone" to harden. When one piece has been placed, the positioner can be moved to another job by one man.

It is envisaged that the positioner could be controlled by an automatic device instead of human operators; it has not been explained how feedback of the position of a component would be achieved.

One of two operators positioning a jig component by reference to telescopes; the component is fixed in position within 0·0002in by means of "Kerrstone." Inset—one of the control boxes: the switches move in the correct sense

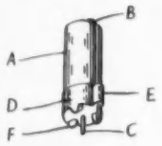
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

ELECTRONICS

872,071. May 5, 1959.—ELECTRICAL CAPACITORS, A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garratt Lane, Wandsworth, London, S.W.18. (*Inventor : Norman Francis Odell.*)

This invention is more especially concerned with capacitors suitable for insertion into printed circuit panels. The capacitor shown in the drawing comprises a capacitative unit enclosed in a tubular casing *A*. The unit, which is not shown, is of the type in which dielectric material and metallic electrodes are rolled together and a terminal lead is fixed to each end of the roll, the terminal leads projecting axially of the roll ; the electrodes may comprise layers of metallic foil or metallised areas on the dielectric. Casing *A* is of thermoplastic material moulded around the capacitative unit so that the terminal leads *B* and *C* from the unit project from each end of the casing. Terminal lead *B* at one end is bent around the outside of the casing as shown so that it projects beyond the other end of the casing and points in the same direction as lead *C*. The end of the tubular casing from which the lead *C* projects is formed with a portion *D* of enlarged diameter ; a hollow rib *E* projects from the enlarged portion *D* and extends axially of the tubular casing. The terminal lead *B* passes through the hollow rib *E* and

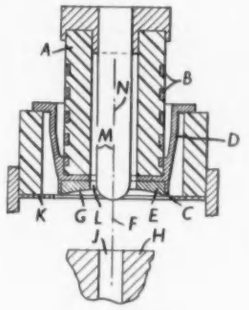


No. 872,071

is firmly held therein. Accurate location of the terminal leads of a capacitor is needed for automatic methods of assembly of the capacitors into printed circuit panels. Capacitors according to the present invention have two terminal leads projecting in the same direction, the leads being firmly held in spaced relationship. The end face of the enlarged portion *D* of the casing is provided with three small, symmetrically spaced pips *F*. These pips provide a stable seating for the capacitor on a printed circuit panel ; the pips also space the capacitor from the panel and thus protect the main mass of the capacitor from the effect of heat during the soldering of the capacitor to the panel. Furthermore the pips prevent the formation of a narrow space between the panel and the capacitor which could lead to bridging between the leads by solder penetrating the holes in the printed circuit panel during the soldering operation. The pips are shown as small tapering feet extending radially inwardly from the periphery of the cap but they may take any suitable shape. The specification shows a further form of capacitor in which the tubular casing is of uniform diameter over its whole length.—*July* 5, 1961.

872,170. November 10, 1956.—ELECTRON-BEAM DISCHARGE TUBES, Ferranti, Ltd, Hollinwood, Lancs. (*Inventors : John Robert Pickin and Ronald Dawson Phillips.*)

In normal klystron use, the ring-like electrode (sometimes referred to as the focusing electrode) is maintained at the same potential as the cathode or at a potential slightly negative with respect to the cathode, both these electrodes being in each case maintained at a high negative voltage with respect to the anode. With such an arrangement some difficulty has been experienced, especially in high-power applications, over modulating the beam, which expression should be understood as including switching the beam. An object of the present invention is to provide for an electron-beam discharge tube an electron gun in which the beam-modulation arrangements are such as to require considerably less modulation power to effect cut-off than in known arrangements, without appreciably altering the focus or the beam shape when the beam is partially cut-off. The accompanying drawing shows parts of an electron gun in accordance with one embodiment of the invention. The gun for a high-power klystron oscillator includes a rigid elongated insulator *A* secured at one end to a support (not shown) and arranged to be heated by the passage of a current through a helix *B* of refractory metal formed by a coating process in a helical groove cut in the surface of the insulator. To the other end of the insulator is brazed a thin disc *C* of molybdenum or other suitable refractory metal having a skirted portion *D* extending over a part of the helical coating but not in contact with it. The free face of disc *C* carries the cathode proper in the form of a porous tungsten disc *E* impregnated with emissive material



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and being on its free surface slightly dished normal to and centred on the centre line *F* of the beam to provide the cathode emissive surface. In front of the emissive surface *G* is an anode *H* having a cylindrical aperture *J* aligned with the beam ; the distance of the anode from the cathode as depicted in the drawing is not to scale. Surrounding the beam between cathode and anode is a ring-like focusing electrode *K* supported from the skirted portion of the cathode by way of a cylindrical insulator. Emissive surface *G* is provided with a central aperture *L* extending coaxially through the cathode, disc and insulator. Through this aperture passes a rod-like electrode *M* disposed so that in operation the centre line *N* of the rod is in alignment with centre line *F* of the beam. Aperture *L* is just large enough for the rod to pass freely through the cathode with sufficient clearance to ensure electrical insulation between the rod and the cathode without risk of breakown. In operation, the cathode is raised to a high negative potential with respect to the anode, thereby originating the beam. The modulation is applied both to the ring electrode *K* and the rod electrode *M* in a negative sense with respect to the cathode. By this arrangement it is found that the beam can be cut-off by a modulation potential of only 0·1 V. Moreover, provided the extent of protrusion of the rod electrode towards the anode is appropriate to the conditions of operation, the presence of this electrode within the beam prevents any appreciable alteration of the focus or beam shape when the beam is partially cut-off.—*July* 5, 1961.

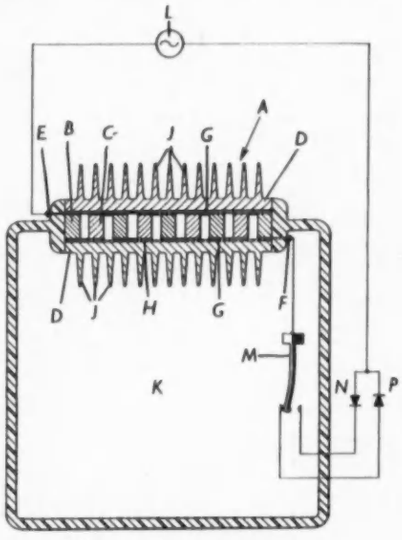
871,367. July 19, 1956.—COLOUR TELEVISION RECEIVERS, Electric and Musical Industries, Ltd, Blyth Road, Hayes, Middlesex. (*Inventor : Eric John Gargini.*)

The object of the present invention is to provide an improved television receiver of relatively simple construction, requiring only a single cathode ray image reproducing tube with only a single gun the beam of which is controlled in intensity. According to the invention, a colour television receiver has a cathode ray tube the fluorescent screen of which comprises a cycle array of parallel phosphor strips transverse to the line scanning direction and emitting different colours when excited by the cathode ray beam. Means are provided for producing from received television signals a first received signal component representing the brightness of the picture to be produced ; a second component representing the hue of the picture ; and a third component representing the saturation. The invention is based on the fact that any colour can be regarded as composed of white together with a component of predetermined hue, the amount of white being zero in a saturated colour. In a television receiver according to the invention, if the scanning velocity of the beam in the line scanning direction is uniform, and the phosphor efficiencies are adjusted in manufacture the beam will excite the different phosphors for equal times and reproduce white. On the other hand if the beam can be caused to dwell for different times on different phosphor strips it will preferentially excite selected strips and therefore reproduce a desired colour ; it will remain however for the same time on each group of phosphor strips. For example, assuming that the phosphor strips are arranged in groups of three, each group consisting of a red phosphor, a green phosphor and a blue phosphor, a green colour can be reproduced by causing the beam to dwell on the green strips of successive groups and to pass rapidly (theoretically instantaneously) over the red and blue strips. Similarly a pastel green can be produced by so controlling the line scanning waveform of the beam, and possibly also its focus that the beam dwells on each of the phosphor strips, but dwells for a long time on the green compared with the red and blue so as to mix a desired proportion of white with green to reproduce the pastel shade. Moreover as the beam takes substantially the same time to cross each group of phosphor strips, brightness modulation of the reproduced picture can be produced simply by modulating the intensity of the beam. Control of the line scanning waveform is preferably produced by superimposing an oscillation on it which is modulated in phase in dependence upon the hue of a colour to be reproduced, and modulated in amplitude in dependence upon the saturation of the colour. The invention is capable of producing simple colour television receivers inasmuch as the detection of the colour information is carried out at the surface of the tube so that a substantial degree of circuit economy is obtained.—*July* 28, 1961.

THERMOELECTRIC DEVICES

872,203. December 9, 1958.—APPARATUS FOR AUTOMATICALLY CONTROLLING TEMPERATURE, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. (*Inventor : Robert Arthur Hilbourne.*)

It is well known that the passage of an electric current through a junction of a thermocouple either liberates or absorbs heat at the junction depending on the direction of the current through the junction. It will be appreciated that since this effect is reversible a thermoelectric device comprising one or more thermocouples may be used as a reversible heat pump. It is an object of the present invention to provide an apparatus of simple form which utilises such a reversible heat pump in automatically controlling temperature. Referring to the drawing, the appa-



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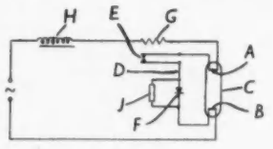
ratus includes a heat pump *A* incorporating a number of thermocouples, each thermocouple comprising two small rectangular blocks *B* and *C* of square cross-section, the two blocks being respectively of materials having thermoelectric powers of opposite signs, for example, p-type and n-type bismuth telluride. The thermocouples are sandwiched between a pair of rectangular copper plates *D*. Alternate blocks *B* or *C* in the line are of the same material. Each block other than the two at the ends of the line has one of its end faces electrically connected to the corresponding end face of the block on one side of it and its other end face to the corresponding end face of the block on its other side. Terminals *E* and *F* are respectively connected to the free end faces of the blocks at the ends of the line, the connections being constituted by thin copper strips *G* having a width equal to that of the plates *D*. The faces of the copper plates adjacent to the blocks are covered with

mica sheeting *H* of such a thickness that the plates are electrically, but not thermally, insulated from the copper strips. The thermocouples are thus connected electrically in series between the two terminals *E* and *F*, the thermocouple junctions formed by the copper strips *G* being in thermal contact with one or the other of the copper plates *D*. The heat pump is mounted so that one set of fins *J* projects into the enclosure *K* and the other set lies outside the enclosure. The terminal *E* is connected to one terminal of an alternating current source *L* and the terminal *F* is connected to the moving contact of a single pole two-way thermally actuated bi-metallic switch *M*, mounted within the enclosure *K* so as to be responsive to the temperature within the enclosure. The fixed contacts of the switch are respectively connected via two rectifiers *N* and *P* to the second terminal of the current source. Due to the Peltier effect, current flow through the heat pump in one direction causes heat to be liberated at all the thermocouple junctions which are in thermal contact with one copper plate *D*, and heat to be absorbed at the thermocouple junctions in thermal contact with the other plate, reversal of direction of current through the heat pump reverses the direction of heat transfer. Thus the space within the enclosure is heated when current is passed in one direction through the heat pump and cooled when current is passed in the other direction. Rectifiers *N* and *P* are connected so that current passes through the heat pump from the current source in such a direction as to heat the space within the enclosure when the switch *M* is in its low temperature condition, and in such a direction as to cool the space when the switch is in its high temperature condition. Hence, the apparatus tends to maintain the temperature within the enclosure within a narrow range of temperatures determined by the characteristics of the switch *M*.—*July* 5, 1961.

ELECTRIC LIGHTING

871,929. March 21, 1958.—STARTING AND OPERATING DEVICE FOR ELECTRIC DISCHARGE LAMPS, Patent - Treuhand - Gesellschaft fur Elektrische Gluhlampen m.b.H., Windenmacherstrasse 6, Munich 2, Germany.

It is already well known that in order to obtain quick starting in a.c. operated discharge lamps, the electrodes may be supplied with increased preheating current through a rectifier in series with a thermal switch. With such an arrangement preheating current is much increased compared with the normal operating current limited by the choke coil, because the choke has a lower resistance to direct current than to pure alternating current. Special measures must, however, be taken if the kind of thermal switch used is liable to maintain the increased current for too long a time. According to this invention it is proposed to connect an automatic electrical element in parallel with the rectifier, which element transmits in the beginning scarcely any current and becomes, after some time, transmissive with the result that the increase of the effective current value caused by the rectifier has its influence for some time only. One such arrangement is shown in the drawing, where electrodes *A* and *B* of the fluorescent lamp *C* are bridged by a line *D* in which a starting switch *E* and a rectifier *F* are connected. The heating winding *G* of the bimetallic starting switch *E* is also connected in series with the discharge tube as is the current limiting choke coil *H*. In parallel with



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the rectifier there is connected a hot conductor resistor *J*, e.g. a resistor of uranium dioxide. In the starting condition the bimetallic switch *E* is closed. On connecting the circuit across line *D* there flows a heating current which is much increased in consequence of the d.c. component occurring due to the rectifier *F*. This current heats the electrodes and produces a strong magnetic field in the choke coil. Heating winding *G* of the bimetallic switch is simultaneously heated so that after some time resulting from the time constant of the switch the latter interrupts the line *D*. The starting voltage surge of the choke coil causes the fluorescent lamp to start, the auxiliary circuit being also brokent. In the aforementioned case it may happen that because the contacts of the starting switch become joined, the circuit is not interrupted so that the choke connected in series or one of the filamentary electrodes connected in series burns out. In order to prevent such damage, current passes after one to two minutes through the hot conductor resistor *J* whereby the d.c. component is brought again to zero after a short time.—*July* 5, 1961.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

INSULATOR AND CONDUCTOR FITTINGS FOR OVERHEAD POWER LINES. PART I : PERFORMANCE AND GENERAL REQUIREMENTS

No. 3288, Part I : 1960. Price 5s. There has long been a need for standards of performance for the various fittings used on overhead power lines in close association with the insulators and conductors. The part now published gives general requirements and specifies tests. It applies to almost all types of fitting and to fittings made of any material. A second part, now in preparation, will be concerned with dimensional standardisation and will be confined to a limited range of fittings, based on present practice in the United Kingdom. The mechanical requirements of the standard are related to the failing load of the fitting which is, in effect, the highest reading that can be obtained on the testing machine, regardless of the method of failure. Thus, difficulties resulting from differing views on permanent set, yield point and ultimate strength have been avoided. It is left to the user to decide on the relationship between the maximum working load and the specified minimum failing load, to suit all the circumstances and any relevant statutory regulations. It is recognised that some of the tests, particularly the heating-cycle test for tension and non-tension joints and anchor clamps, are not yet established in commercial practice. Therefore it may be necessary to review the specification after a shorter than normal interval, with a view to making amendments suggested by experience.

PEARLITIC MALLEABLE IRON CASTINGS

No. 3333 : 1961. Price 4s. 6d. A level of quality for pearlitic malleable iron castings and tests for ensuring that castings come up to this standard are laid down in B.S.3333 which has just been published. The properties specified in this new British Standard can be obtained by various manufacturing techniques; the standard therefore does not stipulate any particular process. Castings are divided into two grades and requirements and tests for tensile strength, permanent set stress, elongation and hardness are laid down for each grade. Requirements are also laid down for microstructure workmanship and finish of castings.

The standard deals with heat treatment of test bars, the number to be tested and the procedure to be followed if a test bar fails for any reason but the presence of primary graphite. Dimensions are also specified for tensile test bars, with alternatives based on practice in several other countries. These alternatives are included to allow experience to be gained with them in the United Kingdom and to facilitate the exchange of information with other countries. Unless the purchaser wishes to inspect the castings at the manufacturer's works, manufacturers are required to provide a certificate stating that the material complies with the standard.

INVESTMENT CASTINGS IN METAL : PART 2 : HIGH ALLOY STEELS, NICKEL AND COBALT ALLOYS

No. 3146 : Part 2 : 1961. Price 8s. 6d. This British Standard has been prepared to meet the needs of industry in the rapidly growing field of investment castings. It does not specify castings made by shell moulding, but only those made by a process which involves the investment of an expendable panel by refractory slurry. The advantages of investment castings of the type described in this Standard are the complexity of the shapes that can be cast and the accurate approach to final form that can be obtained without a large amount of machining which may be difficult. These advantages apply particularly to material which is extremely hard or tough. Section One covers the general requirements and specifies the process of manufacture, the method of identification of the casting, the procedure for testing both mechanically and by known destructive methods and the arrangements necessary for repairing castings. Section Two covers the specific requirements of eighteen different types of castings, many of which are sub-divided into two or three grades. The chemical composition of each type of casting is specified in detail, together with the mechanical properties which are required.

MEASUREMENT OF SMOKE EMISSION FROM INDUSTRIAL BOILERS

No. 2978 : 1961. Part 2. Price 7s. 6d.—The B.S.I. Committee which has been investigating the extent to which smoke from industrial boilers can be reduced by good practice has published this second report covering coal fired shell boilers with various types of mechanical stokers. It is stated to be unlikely that further reports, other than addenda to those already published, will be issued as the majority of other plant in general use comes under the supervision of Government inspectors.

This report is expected to be of value to factory management and to local authorities in helping them to achieve a good standard of smoke control and compliance with the law under the terms of the Clean Air Act. To obtain the material on which the report is based, the B.S.I. Committee carried out tests on eight shell boilers of modern design, known to be well-operated, in various industrial establishments. Detailed records were kept of smoke emission from each of these plants over periods of from three to eight weeks.

In the report a resumé of results for each of the boilers is given in the form of a table, with notes on the frequency with which various associated operations were performed and the level of smoke emission during such operations. The final conclusion is that "dark smoke from well-designed and correctly operated shell type boilers with mechanical firing equipment of the types tested should not exceed eight minutes in any period of eight hours."

Catalogues and Brochures

HALL AND PICKLES, Ltd., P.O. Box 116, Manchester, 1.—Booklet describing the "Hydra" range of high-speed and other tool steels, engineers' cutting tools, tungsten-carbide tipped tools and mining and quarrying drill bits, together with stainless and heat-resisting steels of various types. Analyses and properties are stated, and typical uses are given.

STEWARTS AND LLOYDS, Ltd., Brook House, Upper Brook Street, London, W.1.—Brochure entitled "Tollcross Steel Foundry," giving an illustrated description of the facilities and typical products of the works. Tollcross Foundry, Glasgow, was built on a virgin site a few years ago at a cost of £1,000,000 and produces steel castings up to 8 tons individual weight in many different specifications. The weekly output is 100 tons. Chapters in the brochure deal in turn with pattermaking and production planning, steelmaking, moulding, dressing, heat treatment, laboratories, inspection, machining, hydraulic testing, typical products, and steel specifications. The brochure is profusely illustrated in black and white and colour.

HENRY WIGGIN AND CO., Ltd., Wiggin Street, Birmingham, 16.—Brochure, illustrated by half-tone blocks and dimensioned drawings, on the use of high nickel alloys in pickling plant. There are three sections, dealing with the problem of pickling generally, pickling plant, and pickling equipment such as suspension chains and baskets. Pickling of iron and steel, both in sulphuric and hydrochloric acid, and of brass and copper are dealt with, and the brochure goes on to describe different types of pickling plant and the use of Monel metal for tie-rods and other parts. Handling equipment for immersing components in the pickling liquid varies from simple chains to mechanical handling gear, and many different types are illustrated.

HOT DIP GALVANIZERS ASSOCIATION, 34 Berkeley Square, London, W.1.—Booklet entiled "Corrosion Resistance of Hot Galvanizing." The Association is a non-trading body, composed of the leading general galvanizers in the British Commonwealth, affiliated to the Zinc Development Association, and the present booklet is the first of a series designed to give up-to-date information on the performance of hot dip galvanizing under various conditions. Properly carried out galvanizing provides an excellent and inexpensive corrosion resisting coating for steel, but like other means of protection it is not completely universal. The booklet warns prospective users of certain cases where galvanizing is unsuitable, and gives information on simple precautions which are necessary to ensure proper performance in some applications.

INCANDESCENT HEAT CO., Ltd., Smethwick, Birmingham.—Brochure describing the Lee Wilson open coil annealing process, for which Incandescent are the British agents. Steel sheet, produced in coil form, can be annealed in coil in box furnaces, it can be uncoiled, drawn through a furnace and recoiled, or it can be cut to sheet length and annealed after cutting. All these conventional processes have their disadvantages, and the open coil process is designed to combine the best features of the box and continuous methods without their inherent operational faults. The novel feature of open coil annealing is the provision of an air space between individual wraps of a coil so that the annealing atmosphere gas can circulate freely ; the complete coil can thus be heated and cooled much more rapidly and evenly than in conventional box annealing. Gas-metal reactions can also be carried out in the furnace. Wrap separation is achieved by nylon string, corrugated strip or formed wire, and the coil is rewound in "tight" form ready for further processing after annealing.

Advanced Engineering Courses

Techniques of Non-Destructive Testing. PHYSICS DEPARTMENT, BRUNELL COLLEGE OF TECHNOLOGY, Woodlands Avenue, Acton, London, W.3. An evening course of eleven lectures, every Wednesday from 7 p.m. to 8.30 p.m., commencing Wednesday, October 4, 1961. The lectures will be on topics such as radiology, ultrasonics, eddy currents, magnetic methods and thermal conductivity. Fee £1.

Metal Cutting Principles. THE UNIVERSITY OF BIRMINGHAM, Institute for Engineering Production, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. A two-week course, planned by Professor Milton C. Shaw, head of the Metals Processing Division of the Massachusetts Institute of Technology, U.S.A., intended for senior production engineers. The course runs from August 21 to September 1, 1961. Fee 70 guineas, covering all residential charges and meals.

Corrosion Problems in the Electrical Power Industry. EXETER CORROSION SUMMER SCHOOL, Battersea College of Technology, London, S.W.11. For the first time, the Corrosion Summer School is concerned with the particular aspects of corrosion met in one industry. Starting with boiler feedwater, corrosion and its prevention are surveyed as they affect each stage of generation, concluding with transmission and distribution. The course is being held from September 25 to 28. It is hoped to arrange a visit to Central Electricity Research Laboratories, Leatherhead, on Thursday, September 28. Fee £10.

The Principles of Rotodynamic Machines. BOROUGH POLYTECHNIC, Borough Road, London, S.E.1. A course of thirteen lectures to be given on Tuesday evenings, commencing September 26, 1961, at 6.30 p.m. The course will be concerned with the principles of certain hydraulic turbines and rotodynamic pumps. It is intended for students who have previously qualified in mechanics or fluids to Higher National Certificate standard, or who hold another suitable qualification. Fee £6.